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PART 1 - GENERAL

1.01 SUMMARY

A. SECTION INCLUDES:

1. Pools
2. Spa
3. Interactive Water Feature
4. Water Feature & Fountains
5. Pool equipment room
6. Chemical room
7. Pumps
8. Piping systems
9. Filters & chemical treatment equipment
10. Electrical control panels & systems
11. Other specified equipment
12. Decking and Deck Drainage System and associated accessories
13. Other specified equipment

B. COMPLETE BUILD SCENARIO OVERVIEW

1. Refer to DEFINITIONS: COMPLETE BUILD SCENARIO
2. General:
 - a. The Contractor must provide the following Complete Build scenario services with all design documentation and construction services:
 - 1) Delegated Engineering Services to create and generate the required submittals, including design, and signed and sealed shop drawings. Refer to:
 - a) SUBMITTALS
 - b) QUALITY CONTROL
 - 2) Completed assemblies, including their construction, design, equipment, formwork, and all related installation with finished materials, products, services, and commissioning
 - 3) Execution & implementation including all design, construction, and installation services
 - 4) Certifications as required herein
 - b. On projects located where freezing climates/temperatures are possible, the Contractor must provide design & implementation for the winterization system.
 - 1) Incorporate low-point piping drainage to vertical sump/tank connections and to a related sump pump(s) to vacate and drain all fluids/water for all conduits, water pipes, & air piping systems
 - c. On all on-grade and below-grade projects, the Contractor must provide complete sub-grade drainage systems & de-watering to provide ground-water removal (via Contractor-provided de-watering systems) pumping such water spoils to a remote governmental-authorized outfall.

- d. The Contractor must provide electrical power systems, fabricated, pre-assembled electrical control panel systems, conductors, connectors, junction boxes, rigid & flexible conduits, industrial ground fault circuit interrupters, bonding, earthing, & grounding systems.
- e. The Contractor must provide pool water heater(s), heat pump(s), related ducting, flues, exhaust, powered ventilation systems, & drain piping to waste.
 - 1) Provide a gas regulator for each gas-powered heater/boiler; each gas regulator must be selected based upon the gas pressure available in compliance with the heater manufacturer's requirements incorporating the available gas supply and pressure to the Contractor-included gas regulator aligning accurately with the gas heater manufacturer's requirements.
- f. The Contractor must provide:
 - 1) Drainage and drain systems (to an authorized outfall) for mechanical equipment, gas heaters & heat pump systems, and similar components & equipment.
 - 2) Extension & provision of all dewatering spoils to the authorized outfall.
 - 3) Pipe fasteners, hangers, and similar support systems with Stainless Steel (SST) grade 316 hardware while obtaining approval from the Project's Architect or Structural Engineer for components that require structural interface or dependency on the building structure.
 - 4) Electric Control Panels (controls & lighting) pre-fabricated to comply with the Electrical Drawings
 - 5) Collector, reservoir, and surge tanks systems, equalizer piping (for multiple, adjacent basins & tanks), anchoring, reinforced concrete foundations, or similar structures and related components & equipment for their operation
 - 6) Compressed Air Systems per the manufacturers' requirements and size the compressed air system to prevent rapid cycling (on/off) activities.
 - 7) Wet play-type structures with related governmental-required barriers.
 - 8) Lifeguard & safety plans, rules, signage, and training for operating procedures as required by each wet-play manufacturer. This includes:
 - a) Lifeguard studies and overall water life-safety plans for water play areas & structures, climbable wet-play activity dump buckets, and related water attraction activities.
 - b) All such Equipment, Pools, & Rides named in this Section must be designed and constructed within sound engineering practice limits.
 - 9) Permanent safety-railing system for elevated platform fall protection. (SRC Permanent Rail) at the perimeter edges of each pump pit (sump).

C. RELATED WORK PROVIDED BY ARCHITECT/OWNER

- 1. Refer to the Architect/Owner for the following design & engineering related services:
 - a. Designs for slip-resistant impervious decking, pool mechanical room(s), pool chemical room(s), and sanitary facilities (restrooms):
 - 1) Positive draining slopes within the containment vault basins, on concrete floors, non-absorbent, & slip-resistant, must slope to the required floor & nuisance drains designed, located, & provided by the Architect's Drawings.

- 2) Waterproofing of the containment vault and interstitial spaces (before the placement of the pool basins)
- 3) The equipment room size and layout provide clearances for all equipment prescribed by the manufacturer to allow regular maintenance and removal without disturbing other piping or equipment.
 - a) Equipment not rated for outdoor use must be within a room or similar enclosure.
 - b) Incorporated stairways for multi-level or below-grade access must comply with local codes for railings, safety barriers, and OSHA safety requirements.
- b. The Architect and his Structural Engineer must incorporate a required space allocation allowing for the operator's placement and removal of equipment from the lower level equipment space to the upper level of the mechanical room space.
 - 1) A clear space of 5'-0" x 5'-0 is recommended to allocate space immediately adjacent to the floor elevation change at the upper and lower levels.
 - 2) An overhead beam and chain hoist must be provided for in the Structural Engineer's design, sufficiently sized to remove the heaviest, most substantial equipment component, plus a 25% safety factor for variables in replacement equipment in the future.
 - 3) A removable safety guard rail must be placed near the edge of elevation transition when not used for assistance to prevent fall with an added safety protection. Safety yellow markings must be located on the floor surfaces to ensure the clear-vacant space is maintained.
- c. Civil engineering includes site utilities, drain piping (from Martin Aquatic's points of connections with a recommended minimum 2% slope in the drain & gravity flow piping to accept the ADE estimated water flows to the authorized outfall).
 - 1) The Civil or MEP Engineer must determine the dewatering, overflow, and waste outfalls, gravity-flow requirements, pipe size, & slope as appropriate.
 - 2) Critical: No direct connections between the pool waste/backwash piping and a sanitary sewer is allowed.
- d. Project structural engineering for mechanical equipment rooms, chemical rooms, pilings, piers, retaining walls, all waterproofing, and the following reinforced concrete structures:
 - 1) Below-grade Reservoirs & Tanks
 - 2) Below-grade Vaults
 - 3) On-structure (above-grade) reinforced, water-proof concrete structures to accommodate pool basins, incorporate into the building's concrete structures the following:
 - a) drains at structures low point(s) to authorized outfalls
- e. Geotech Consultant/Engineer to specify the recommendations, requirements, and methodology for placing pilings, piers, anchors for the basins, and engineered backfill beneath, around the pool basin(s), site-located tanks, piping trenches, and dewatering required for the pool(s) basins & tanks.

- 1) These Geotech / foundation recommendations must be the final determining factor when piles are required due to related sub-standard soils, suspected sinkhole activity, unsuitable soils, organic materials, or specific codes relating to anchoring for storm events or tidal surges.
 - 2) A locally-licensed Geotechnical Consulting Engineer must determine that the assumed design load-bearing capacity of 2,000 psf [0.96 bars] is available at each basin & tank location(s).
 - 3) The Geotech must determine the necessity of placing specialized soils and support beneath the piping systems' trunk lines serving the pools and the anticipated dewatering for the basin, pipe trench, & tank excavation.
- f. Project MEP, HVAC, & Detailed Dehumidification inclusive engineering services
- 1) All Indoor & outdoor MEP design/engineering to Martin Aquatic's points of connections
 - 2) Provide the design for backflow prevention, pressure reduction, and water hammer prevention assemblies within the water supply piping systems to the pool mechanical & chemical equipment rooms.
 - a) Refer to the MEP's Drawings for the design of the water hammer arrestor(s) and pressure reducing assemblies to protect the auto-fill system(s) from hydraulic potential water hammer or hydraulic shock.
 - b) Floor drains, nuisance drains, and similar
 - c) Pool makeup water supply is from an approved potable water system or meets those requirements with bacteriological/chemical reports to the local government health department.
 - 3) Dehumidification, cooling, exhaust to outdoors, heating of room spaces, exhaust gas ducting systems, HVAC/Exhaust systems without exception floor-level exhaust ventilation systems, or similar activities. The following recommended minimum exhaust rooms' space ventilation standards are at least (and greater if the MEP engineer deems appropriate or code-required):
 - a) Pool mechanical rooms: 10 x air changes / hour
 - b) Chemical equipment rooms: 20 x air changes / hour
 - c) Combustion air for fossil-fuel heaters: As required
 - d) Ventilation air supply for heat pumps: As required
 - e) Ventilation for interstitial space around stainless steel pool basin As required
 - 4) For sizeable electrical supply and loads, Codes' components & equipment may be required to be placed in a separate, designated functional electrical room with dual points of egress and requiring enhanced, code-required clearances. The Architect, with his selected project MEP Engineer, must determine the building requirements pertaining to Electrical Requirements and related electrical enhancements & safety procedures.
 - 5) Pool deck illumination to comply with local governmental codes.
- g. Chemical & Equipment rooms and yard illumination must achieve a minimum 30-foot-candles measured at the floor/ground level.

- h. Authorized Night Swimming and Outdoor Swimming areas spaces require specialized illumination levels. An Owner-selected design professional must provide such illumination professional services for the design services, directions to the Contractor, and finally, oversee its successful completion.
- i. The Owner must provide, in conjunction & coordination with the selected contractors, delegated specialty engineer, manufacturers, vendors, lifeguard studies and overall water safety plans for all water play areas & structures, and climbable wet-play related water attraction activities.
- j. Landscape Architecture inclusive of appropriate selections for decking, deck drainage, deck shower(s) locations on the outside deck area, and selection of appropriate finish materials at and within (with selected colors & textures) the pool, smooth slip-resistant finishes, and surfaces, and with its perimeter edges finishes and textures. Wooden decks are prohibited.

1.02 GENERAL DESCRIPTION OF WORK & SYSTEMS

A. COMMON FOR ALL

1. Each pool must be constructed of reinforced shotcrete wall/floor construction concrete or other approved, structurally rigid impervious materials with a nontoxic, smooth, and slip-resistant finish, surrounded by vapor barriers. These pools must be of such shape and design to be operated and maintained safely and sanitary.
2. The layout of pools and noted pool related work
3. Project benchmarks, control points, elevation, and waterline adherence controls
4. Dewatering, excavation, placement of engineered backfill in partial lifts (as determined necessary by the Geotechnical Engineer), crushed stone fill, sequenced backfill & compaction required below pool basin structures, concrete/shotcrete level formwork, tank structures, pipe trenches, and the piping hangers/supports.
5. The collector/reservoir/surge tanks are poured-in-place, waterproof, reinforced concrete, or other impervious materials with a smooth slip-resistant finish, surrounded by vapor barriers, and reinforced shotcrete wall/floor construction reinforced concrete (unless noted otherwise herein).
6. Pool hydraulic/mechanical systems must include water recirculation, filtration systems, perimeter gutter overflow gravity-flow collection, activity & specialized static and automated feature, weir, nozzle pumping systems, and collector/reservoir/surge tanks. Related primary & automated water chemical treatment, related equipment systems must include an advanced, automated chemical controller, saline/chlorine generation, UV sterilization systems, secondary chlorine, and pH feeder systems.
7. Specified LED lighting intensity, lighting controls, low voltage control, automated and static nozzle/weir systems
8. Water heating systems including coordination for their ducting, insulation, with related controls, ducting, venting, water supply & discharge for geothermal and its piping systems
9. Nozzle, water activity, and weir hydraulic/mechanical systems, including related piping control systems
10. Interior and surface resilient, slip-resistant finishes for concrete pool basins and wet decks as detailed herein or specified by the Landscape Architect.

11. IWF Wet Deck performance requirements: Provide a single layer EVA-rubber copolymer tile wet area surfacing system designed, manufactured, and installed to meet the following criteria:
 - a. Shock Attenuation (ASTM F1292): 3/8" meets 1' critical fall height; 7/8 inch meets 4' critical fall height; 1 ¼ inch meets 6' critical fall height
 - b. Gmax: Less than 200.
 - c. Head Injury Criteria: Less than 1000.
 - d. Flammability (ASTM E648): Class 1
 - e. Toxic Characteristic Leaching Procedure (TCLP) (RCRA) by Method 3010: Pass.
 12. Pool wet deck accessory equipment indicated or specified (including required embedded deck anchors and ballast supports) within or adjacent to the pool basin and its adjacent deck
 13. Coordination & provision for electrical operational & safety interlocks, flow and safety controls for pools, safety cut-off, specialty equipment control systems, industrial ground fault circuit interrupters, time-delay relays, water level, and wind velocity control systems.
 14. Miscellaneous pool systems' testing equipment, safety procedures implementation, and noted equipment automation control systems
 - a. Provide necessary pressure pumps & related equipment for enabling successful water-pressure testing as required herein.
 15. Commissioning of all pool systems, documentation, color-coding, directional flow arrows, comprehensive labeling, and specified operator training
- B. POOL, SPA, AND FEATURES INCLUDED
1. Refer to these Design Documents (Drawings and Technical Specifications) for the various designed-pools engineered and specified by accompanying descriptive narratives describing and explaining the design criteria utilized by This Engineer. The Contractor must provide all required noted and specified certifications, components, equipment systems, materials, labor, supervision, & testing.
- C. WET PLAY, CLIMBABLE STRUCTURES, & RELATED SYSTEMS
1. Martin Aquatic provides the engineering design for the chemical treatment, filtration, and hydraulics design for feature water supply. The design target water flows were provided to Martin Aquatic by the respective manufacturers/vendors.
 - a. Except for the aforementioned limited water flow, filtration, and chemical treatment design by Martin Aquatic, the balance of the work scope & site-wide lifeguard studies with the life-safety plan is Complete Build Activities by the Contractor and Owner.
 - b. The balance of these activities & works scope is by the Contractor as a Complete Build Scenario.
 - c. Refer to the COMPLETE BUILD SCENARIO OVERVIEW.
 2. See below for a partial listing of Contractor responsibilities.
 - a. The placement and positioning of all such equipment must comply with appropriate codes, standards, and Delegated Engineer's professional judgment.

- b. Additionally, the Contractor, his Delegated Engineers, and each manufacturer/vendor must originate/provide written operator training, lifeguard studies, overall water life-safety plans, safety instructions, user rules, and safety signage for the following Complete Build Scenario Activities:
 - 1) Wet Play Structural Wet-Deck (or basin), designs including finished implementation for reinforced concrete foundations, wind-loads' design, structures inclusive of elevated feature nozzles, stairs with deck platforms, dumping buckets (and related activities), play features, complete finish materials with described/specified safety surfaces, barriers (netting & overhead), related equipment/hardware, communications, lighting design, & its execution.
- c. Refer to the COMPLETE BUILD SCENARIO OVERVIEW for all of the above.

D. CHEMICAL AND POOL EQUIPMENT ROOMS

- 1. The pool equipment assemblies located in the Chemical / Equipment Room(s) (or Equipment Yards) include:
 - a. Specified filtration systems with metering, gauges, valving, and flow controls,
 - b. Specified individual filtration & feature pumping systems,
 - c. Equipment not rated for outdoor use must be located indoors without exception.
 - d. Chemical automated controls, designated chemical feed, saline/chlorine generation, UV sanitizing, including related assemblies, specialized components with equipment, pH adjustment controls with related acid feed pumps, and noted automated monitoring systems,
 - 1) Critical:
 - a) Chemical & mechanical rooms must not store bulk chemicals emitting corrosive fumes or supplies that block access to equipment.
 - b) A room or space must be provided for chemicals to be stored in a cool, dry, and well-ventilated area under a roof, and the area must be inaccessible to the public.
 - e. Hose bibb(s) must be provided in the equipment room spaces and deck locations to facilitate maintenance & routine operation of the rooms' & deck areas and installed with anti-siphon devices (vacuum breaker) without exception.
 - f. Reinforced, waterproof, concrete backwash sump(s) with grates, anchors, & frames.
- 2. Complete electrical construction & provision, including shop drawings' portions of its design, engineering, & construction implementation. The Contractor shall use the Electrical Engineering Drawings from This Engineer as the basis for detailed shop drawings, and detailed control panel fabrication by the Contractor's supplied Designated Specialty Electrical Engineer's efforts.
 - a. These are Complete Build Activities by the Contractor. Refer to the COMPLETE BUILD SCENARIO OVERVIEW
 - 1) The Contractor must provide Designated Specialty Electrical Engineer's Documents for:

- a) Final design fabrication, design & oversight of shop drawings' preparation & permitting, & provision of electrical power panels, the related control panels' final design & oversight of the control panels' fabrication, each control panel's programming, their sub-panel(s) including relays, controls, safety disconnects, safety-off controls with relays, conductors, connectors, control wiring panels, lighting control panels, junction boxes, power supplies, pull boxes, motor control systems, metering, gauges, sensors, safety systems, circuit breakers, magnetic motor starters, VFD's, Industrial Ground Fault Circuit Interrupters (GFCI), conduits, bonding, earthing, grounding, and other similar electrical componentry.
- 3. Complete air ventilation, combustion air supply, drainage, gas regulators & supply controls, heaters, heat exchangers, exhaust & heater ducting, and venting systems to floor-level suction HVAC pickups.
 - 1) Activities in the above-section D.3 are a Complete Build Activity. Refer to the COMPLETE BUILD SCENARIO OVERVIEW and RELATED WORK PROVIDED BY ARCHITECT sections above.
 - b. Chemical provision & supply, as noted in the chemical equipment sections below.
- 4. Chemical Room(s) must house chemical feeder systems, chemical tanks, secondary chemical storage, and the safety drench shower with its eyewash station.
 - a. Exception: Refer to the Architect for the actual mechanical & chemical room designs. This Section specifies only the aquatics equipment located within the Architect-supplied room(s).
 - b. No bulk chemicals may be stored in the chemical or equipment room spaces.
- 5. Provide custom-fabricated access doors (at least 7-feet x 7-feet), safety ladders, and related components for easy access into designated equipment vaults and collector/reservoir/surge tanks as indicated in the Drawings/Contract Documents.

1.03 DEFINITIONS

A. COMPLETE BUILD SCENARIO:

- 1. This phrase and term identify the total responsibility, means, & methods of the Contractor to provide completely operational assemblies and systems inclusive of Delegated Design or Delegated Engineering Services for choreography, equipment, electrical design, electrical fabricated control panels, wet-play design, as well as other noted performance-based services and installation implementation activities herein.
 - a. The Complete Build Scenario must incorporate:
 - 1) Design & drawing activities, executing & providing required performance efforts, lifeguard and safety planning services, governmental permitting for services, installations, performance-based criteria, similar activities, sketches, submittals, & testing necessary to result in completed systems compliant with permitting requirements, and compliance with related codes & standards.

- 2) The provision by the Contractor of concrete/shotcrete formwork, dewatering activities & systems, level top-of-beam, level infinity/weir finishes, equipment, materials, and services to include those necessary for the Owners' acceptance, compliance with the Drawings, these Specifications, and use for the intended purpose.

- b. The Complete Build Scenario is also referred to as a Complete Build Activity or as a Delegated Design.

B. CONTRACTOR:

1. In general, the Contractor is the Licensed Certified General Contractor or Construction Manager who has overall designated and legal responsibility for constructing the work. The Contractor must be qualified for the project contracted for and means the licensed-person who, for compensation, undertakes to, submits a bid to, or does himself or by others, construct, repair, alter, remodel, add to, demolish, subtract from, or improve any building or structure, including related improvements to real estate, for others, or resale to others; and whose job scope is substantially like the job scope described in these specifications.

C. CONCRETE:

1. The term "concrete," as used in this Section, refers only to concrete (SHOTCRETE and CAST IN PLACE READY-MIX CONCRETE) as specified in this Section only.

D. CRITICAL:

1. This word describes dimensions that are not subject to deviation. Violation of a "critical" dimension obligates & requires rework to bring the item back into compliance.

E. DELEGATED DESIGN:

1. Scope items designed by Martin Aquatic to a performance level, to be later designed and engineered in detail by the Contractor's Delegated Engineering Service engineering providers, and the Contractor's specialty sub-contractors (installers) as appropriate, & the Contractors' Delegated or Designated Specialty Engineer (or other design professional) are referred to as "delegated design."
2. The delegated design may include items such as specialty structural engineering of secondary structural systems, electrical detailed design/engineering of shop drawings, dewatering detailed design/engineering, gas heater gas-supply regulators with accompanying detailed ducting with flues/exhaust design /engineering, and other similar specialties detailed design/engineering items, design portions, & other services as described in the Construction Documents phase scope.

F. FURNISH:

1. The term "Furnish" means to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, testing, and similar operations.

G. INSTALL:

1. The term "install" describes operations at the Project site, including the actual unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, start-up, commissioning, testing, and similar operations. Included in the "Install" responsibilities are the various hardware and materials required to complete the "Install."

H. INSTALLER:

1. The word "installer" or "commercial pool installer" or similar terms denote an individual or firm retained/hired by the Contractor to perform designated, sub-contracted, specialty work. The installer must be licensed and qualified in the areas of layout, forming, excavation, compaction, dewatering, reinforced structures, fiberglass, and similar products, stainless-steel assemblies & components, underwater sealants, trim, decking, piping, and finishes as required or specified to comply with the specific requirements of the Local Governmental Agency for the project's locale. If the Contractor acts as the installer (self-performs), the Contractor must demonstrate the Quality Control requirements. Several products within these specifications require the manufacturer's written certification of the specific installer's qualifications, training, and expertise.

I. MUST:

1. A mandatory-requirement imposing a duty, being obliged to, or grants a right which is mandatory or imperative

J. POOL:

1. The use of the word "pool" within these Specifications must also refer to a basin, decking-supporting slide run-outs, dive-pool, eco-system, feature, fountain, interactive water feature (IWF), lake system, river-ride feature, slide plunge pool, slide system, spa, splash deck, splash pad, spray deck, sun shelf, wading pool, water activity pool (WAP), water feature, water lounge, water play, water recreation attraction, water theme park, wave pool, wet deck, or Wet-Play.
2. Portable/wooden pools/spas are prohibited.

K. PLASTIC PIPING:

1. Any piping that is non-metallic, "plastic," "petrochemical-based," "polymer," or "synthetic" such as PVC, UPVC, CPVC, and HDPE.

L. PROVIDE:

1. The term "provide" means to furnish, install, connect, test, and complete/ready for the intended use.

M. SLIP-RESISTANT (NON-SLIP):

1. A horizontal, non-skid textured surface with a dynamic coefficient of friction rated at a minimum of 0.42 (per ASTM C1028) for wet conditions. The words "non-slip" and "slip-resistant" are equivalent as used in these specifications.

N. SUBSTANTIAL COMPLETION:

1. Substantial completion is the date when a construction project is deemed sufficiently completed, per the Contract Documents, to the point where the Owner can occupy or utilize the work for its intended purpose. This definition of substantial completion is based on the language in the American Institute of Architects form contract AIA A-201: General Conditions and the use of AIA Form G-704-2017, Certificate of Substantial Completion.
 - a. Exception: If the Owner and Contractor have agreed on an alternate, substitute definition of Substantial Completion, then the above definition shall not apply to this project.

O. WET DECK:

1. Pool wet decks must be constructed of concrete or other nonabsorbent material having a textured, slip-resistant finish. The wet deck area finishes' design and its installation comply with the manufacturer's specifications. Wooden decks and walkways are prohibited. An outdoor pool deck must have a minimum of 2% and a maximum of 4% uniform slope away from the pool or deck drains. Flush-installed drains at an IWF must be considered as deck drains.

P. WORKMANSHIP:

1. The degree of applied quality & skill with which a product is made or the completed installation is considered. This project's Contract Documents require that all workmanship quality be observed as excellent.
2. The quality and appearance of the "work" must be "high quality and be subject to the Engineer's judgment as to compliance with expected, excellent workmanship standards. Work deemed by the Engineer as "Sub-Standard" or "Sub-Quality" must not be recommended for the Owner's acceptance.

Q. MARTIN AQUATIC:

1. This acronym refers to Martin Aquatic Design & Engineering, Inc. Also, the use of "This Engineer," or "This Consultant," or "MA," or "Aquatic Design & Engineering, Inc., or "ADE" may be utilized herein interchangeably and refers to Martin Aquatic.

1.04 COORDINATION AND PERMITS

A. COORDINATION

1. Coordinate services and work with other disciplines to afford and enable timely project completion.
2. Schedule inspections
3. Obtain construction authorization from the appropriate governmental agencies as necessary before installing the specified pool and equipment work.
4. Comply with state and local department of health and building agency requirements, including specified construction inspections.
5. Complete documentation & submission of accepted modifications of the approved documents to the governmental permitting authorities.

B. PERMITS WITH RELATED INSPECTIONS

1. The Contractor must obtain and pay for permits, variance hearings & procedures, and arrange for governmental/municipal inspections necessary for the installation of this work to include, but not limited to;
 - a. The building, dehumidification, dewatering, electrical, energy conservation, environmental, exhaust ducting, HVAC, health, gas connections & supply, impact, safety, wastewater disposal, zoning, and similar permits.
2. If specified inspections are not successfully secured, the Contractor must pay all penalties, re-inspection costs, and uncovering completed work when requested/required by the applicable authorities or delegated inspectors.

1.05 PROJECT MEETINGS

1. Attend project coordination meetings specified and as requested by the Architect or Owner's Representative.

1.06 REGULATORY REQUIREMENTS

A. GENERAL REQUIREMENTS

1. Work (quality materials and workmanship) performed under this contract must be in conformance with applicable codes:
 - a. Department of Labor (OSHA)
 - b. Department of Justice (ADA)
 - c. Virginia Graeme Baker Pool and Spa Safety Act (VGB)
 - d. Department of Health, governmental agencies, state and local building codes (see below)
 - e. Contract Documents.
2. The following reference code-publication may be used at This Engineer's discretion. Portions of the MAHC may not apply to this project or deemed to be inappropriate by This Engineer:
 - a. Model Aquatic Health Code (MAHC)
3. Specialty Designated Engineering must be by a licensed professional engineer (per the project's locale) with a professional resume demonstrating his specialty area expertise. Specialty Designated Engineering must be equivalent to Delegated Engineering Services.
4. Bring any contradictions or ambiguities concerning any referenced codes, regulations, requirements, standards, specifications, state or local laws, regulations, local ordinances, fire insurance carrier's requirements, or the Contract Documents to the attention of the Architect or This Engineer.
5. A Contractor-responsibility includes the piping or transport of all pool wastewater to the authorized outfall (sanitary sewer). If local & state codes disallow and prevent discharge/authorized outfall to the sanitary sewer, then without exception, the Contractor must provide the discharge/authorized materials' delivery to the directed outfall per local environmental requirements. The Contractor must provide delivery of all dewatering spoils to the authorized outfall.

B. NONCOMPLIANCE

1. Correction of non-compliant work contrary to the applicable building codes, regulations, ADA, NEC, OSHA requirements, state codes & laws, local ordinances, referenced standards, fire insurance carrier's requirements, and the Contract Documents is a responsibility of the Contractor.

C. BUILDING CODES AND LEGISLATION ACTS

1. Applicable codes must include federal & state laws, statutes, local ordinances, and the applicable requirements of the following accepted & referenced building codes and related legislation:
 - a. Florida Building Code – 6th Edition
 - b. Florida Building Code - Energy Conservation – 6th Edition
 - c. Florida Administrative Code, Chapter 64E-9
 - d. Florida Boiler and Pressure Vessel Act
 - e. Florida Trench Safety Act
 - f. OSHA standards for Trenching and Excavation
 - g. American Disabilities Act (ADA)
 - h. Virginia Graeme Baker Federal Pool and Spa Safety Act (VGB)
 - i. NFPA 70 - National Electrical Code
 - j. Local Municipal Electrical Code and Requirements
 - k. International Building Code and Local Building Codes
2. The latest edition of the applicable codes (in effect when the Contract Document was signed) must apply to this project.
3. Florida: Each Pool: The Pool filtration system is sized for at least 1 gpm per living unit for transient or 3/4 gpm per living unit for non-transient (for multiple pools: cumulative total GPM, excluding spas, wading pools, and interactive water features). Examples: Transient units = required gpm flow; non-transient units x 0.75 = required gpm flow.

D. REFERENCED STANDARDS

1. Standards, Regulations, Codes, and Requirements must be the latest revisions, editions, and additions of the documents and supersede the editions listed.
2. Applicable Criteria and specifications may include the following:
 - a. American Concrete Institute (ACI):
 - 1) ACI 117 - Standard Tolerances for Concrete Construction and Materials
 - 2) ACI 211.1 - Standard Practice for Selecting Proportions for Normal Heavyweight, and Mass Concrete
 - 3) ACI 301 - Specifications for Structural Concrete for Buildings
 - 4) ACI 302.1R - Guide for Concrete Floor and Slab Construction
 - 5) ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
 - 6) ACI 305R - Hot Weather Concreting
 - 7) ACI 306R - Cold Weather Concreting
 - 8) ACI 308 - Standard Practice for Curing Concrete
 - 9) ACI 309R - Guide for Consolidation of Concrete
 - 10) ACI 311.4R - Guide for Concrete Inspection
 - 11) ACI 315 - Details and Detailing of Concrete Reinforcement

- 12) ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary
- 13) ACI 318-11 - Building Code Requirements for Structural Concrete
- 14) ACI 347R "Guide to Formwork for Concrete."
- 15) ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary
- 16) ACI 350-06 - Code Requirements for Environmental Engineering Concrete Structures
- 17) ACI 506.2-13 – Recommended Practice for Shotcreting
- 18) ACI 506.2 - Specification for Materials, Proportioning, and Application of Shotcrete.
- 19) ACI 506.3R-82 - Certification of Shotcrete Nozzlemen
- 20) Comply with building code requirements which are more stringent than the above

b. American National Standards Institute (ANSI):

- 1) ANSI/AWWA C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4-inches [100 mm] through 12-inches [305 mm], for Water
- 2) ANSI / ASTM A13.1-2007 Standard for the Identification of Pipes
- 3) ANSI A108 - Installation of Ceramic Tile
- 4) ANSI A108.1A - Specifications for Installation of Ceramic Tile in the Wet-Set Method with Portland cement mortar.
- 5) ANSI A108.1B - Specifications for Installation of Ceramic Tile on a Cured Portland cement mortar Setting Bed with Dry-Set or Latex Portland cement mortar.
- 6) ANSI A108.1C - Specifications for Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland cement mortar -or- Installation of Ceramic Tile on a Cured Portland cement mortar Setting Bed with Dry-Set or Latex Portland cement mortar.
- 7) ANSI A108.5 - Specifications for Ceramic Tile Installed with Dry-Set Portland cement mortar or Latex-Portland cement mortar.
- 8) ANSI A108.6 - Specifications for Ceramic Tile Installed with Chemical-Resistant, Water-Cleanable Tile-Setting, and -Grouting Epoxy.
- 9) ANSI A108.8 - Specifications for Ceramic Tile Installed with Chemical-Resistant Furan Mortar and Grout.
- 10) ANSI A108.9 - Specifications for Ceramic Tile Installed with Modified
- 11) Epoxy Emulsion Mortar/Grout.
- 12) ANSI A108.10 - Specifications for Installation of Grout in Tilework.
- 13) ANSI A118.1 - Standard Specification for Dry-Set Portland cement mortar.
- 14) ANSI A118.3 - Chemical-Resistant, Water-Cleanable, Tile-Setting, and Grouting Epoxy and Water-Cleanable Tile-Setting Epoxy Adhesive.
- 15) ANSI A118.4 - Latex-Portland cement mortar.
- 16) ANSI A118.5 - Chemical-Resistant Furan Mortar and Grout.
- 17) ANSI A118.6 - Standard Ceramic Tile Grouts.
- 18) ANSI A118.7 - Polymer Modified cement grouts
- 19) ANSI A118.8 - Modified Epoxy Emulsion Mortar/Grout.
- 20) ANSI A118.9 - Test Methods and Specifications for Cementitious Backer Units

- 21) ANSI A118.10 - Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimensional Stone.
 - 22) ANSI A118.1 - ANSI A118.13 - Installation of Ceramic Tile
 - 23) ANSI A118.3 - Chemical Resistant, Water Cleanable Tile-Setting and Grouting Epoxy Water Cleanable Tile Setting Epoxy Adhesive
 - 24) ANSI A137.1 - Standards Specifications for Ceramic Tile
 - 25) ANSI B2.1 – Valves
 - 26) ANSI B16.5 – Class 150 Pipe Flanges
 - 27) ANSI Z124.7 - Prefabricated plastic spa shells
 - 28) ANSI/NSPI 1 – Standard for Public Swimming Pools
 - 29) Comply with building code requirements which are more stringent than the above
- c. ASHRAE - American Society of Heating, Refrigeration, and Air Conditioning Engineers.
- d. ASME - American Society of Mechanical Engineers
- 1) ASME 112.19.8 - Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs (Also ANSI/ASME 112.19.8)
- e. American Society of Civil Engineers (ASCE)
- 1) ASCE 7-05: Minimum Design Loads for Buildings and Other Structures
- f. ASTM - American Society for Testing and Materials
- 1) ASTM A123 / A123M-09 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 2) ASTM 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 3) C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
 - 4) C144, Standard Specification for Aggregate for Masonry Mortar
 - 5) ASTM A193 Standard Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications
 - 6) ASTM A194 / A194M-11 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
 - 7) ASTM A235-10 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
 - 8) ASTM A276 Standard Specification for Stainless Steel Bars and Shapes
 - 9) ASTM A240 / A240M Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - 10) ASTM A307-10 - Standard Specification for Carbon Steel Bolts and Studs
 - 11) ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless-Steel Pipes
 - 12) ASTM A314 - Standard Specification for Stainless Steel Billets and Bars for Forging
 - 13) ASTM A490-12 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength

- 14) ASTM A563-07a - Standard Specification for Carbon and Alloy Steel Nuts
- 15) ASTM A615 - Deformed Steel Bars for Concrete Reinforcement
- 16) ASTM A666, Standard Specification for Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar
- 17) ASTM A706 - Low-Alloy Steel Deformed Bars for Concrete Reinforcement
- 18) ASTM
- 19) ASTM A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
- 20) ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- 21) ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
- 22) ASTM B455, Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Extruded Shapes
- 23) ASTM C31, Making and Curing Concrete Test Specimens in the Field
- 24) ASTM C33 - Concrete Aggregates
- 25) ASTM 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- 26) C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
- 27) C144, Standard Specification for Aggregate for Masonry Mortar
- 28) ASTM C39 – Compressive Strength of Cylindrical Concrete Specimens
- 29) ASTM C94 - Standard Specification for Ready-Mixed Concrete
- 30) ASTM C143 – Standard Method of Test for Slump of Portland cement concrete
- 31) ASTM C150 - Portland cement
- 32) ASTM C260 - Specification for Air-Entraining Admixtures for Concrete
- 33) ASTM C172 – Method for Sampling Fresh Concrete
- 34) ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
- 35) ASTM C231 – Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method
- 36) ASTM C260 – Specification for Air-Entraining Admixtures for Concrete
- 37) ASTM C309 - Specification for Liquid membrane-forming Compounds for Curing Concrete
- 38) ASTM C330 - Lightweight Aggregates for Structural Concrete
- 39) ASTM C482 - Standard Test Method for Bond Strength of Ceramic Tile to Portland Cement
- 40) ASTM C494 – Specification for Chemical Admixtures for Concrete
- 41) ASTM C578-10, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
- 42) ASTM C618 – Specification for Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
- 43) ASTM D256-10 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- 44) ASTM D570-98 - Standard Test Method for Water Absorption of Plastics
- 45) ASTM D638-10 - Standard Test Method for Tensile Properties of Plastics

- 46) ASTM D648-06 – Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
- 47) ASTM D695-10 - Standard Test Method for Compressive Properties of Rigid Plastics
- 48) ASTM D696-08 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer
- 49) ASTM D732-10 - Standard Test Method for Shear Strength of Plastics by Punch Tool
- 50) ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- 51) ASTM D792-08 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- 52) ASTM C1028-07 - Standard Test Method for Determining Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method:1.02
- 53) ASTM D1238-04 – Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
- 54) ASTM D1505 - Density of Plastics by the Density-Gradient Technique
- 55) ASTM D1784 – PVC / CPVC Plastic Pipe Properties
- 56) ASTM D1785 - PVC Plastic Pipe, Schedules 40 & 80
- 57) ASTM D1998 - Standard Specification for Polyethylene Upright Storage Tanks Section 11.3: Low temperature. Impact Test and Section 11.4: Gel Test
- 58) ASTM D2047 Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine
- 59) ASTM D2466 – PVC Schedule 40 Fittings
- 60) ASTM D2467 – PVC Schedule 80 Fittings
- 61) ASTM D2583 - 07 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
- 62) ASTM D2584-11 - Standard Test Method for Ignition Loss of Cured Reinforced Resins
- 63) ASTM D2563 - Fabricated, Fiberglass Wrapped PVC Pipe Fittings
- 64) ASTM D2564 - PVC Pipe and Fittings Solvent Cement.
- 65) ASTM D2855 – Standard Practice for Making Solvent-Cemented Joints with PVC Pipe and Fittings.
- 66) ASTM D4086 - Standard Practice for Visual Evaluation of Metamerism
- 67) ASTM D4101 – Polypropylene Materials
- 68) ASTM D6817 - Standard Specification for Rigid Cellular Polystyrene Geofoam
- 69) ASTM E84-12 - Standard Test Method for Surface Burning Characteristics of Building Materials
- 70) ASTM E303 Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester - Rustic Board Pattern: 43.40; Slate Pattern: 34.90; Slate Smooth: 33; Ripple Pattern: 44.75
- 71) ASTM E648-03 is for "Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source – Passed
- 72) ASTM E903-96 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres

- 73) ASTM E1347 - Standard Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry
- 74) ASTM E1477 - Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
- 75) ASTM F593-02 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- 76) ASTM F402 – Standard Recommended Practice for Safe Handling of Solvent Cements Used for Joining Thermoplastic Pipe and Fittings
- 77) ASTM F437 – CPVC Fittings
- 78) ASTM F439 – CPVC Fittings
- 79) ASTM F441 – CPVC Plastic Pipe
- 80) ASTM F493 - CPVC Pipe and Fittings Solvent Cement
- 81) ASTM F656 – PVC Primers
- 82) ASTM F1292 - Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment: Critical Fall Height 1' or More.
- 83) ASTM F1790 – Ball Valves & Check Valves
- 84) ASTM F2376-17a - Standard Practice for Classification, Design, Manufacture, Construction, and Operation of Water Slide Systems
- 85) ASTM F2461 – Standard Practice for Manufacture, Construction, Operation, and Maintenance of Aquatic Play Equipment
- 86) ASTM G154 – Ability to Withstanding UV Exposure
- 87) Comply with building code requirements which are more stringent than the above
- g. American Water Works Association
 - 1) AWWA D121-12 - Standard for Bolted Aboveground Thermosetting Fiberglass-Reinforced Plastic Panel-Type Tanks for Water Storage
- h. American Welding Society (AWS)
 - 1) D1.6 - Structural Welding Code - Stainless Steel
- i. Concrete Reinforcing Steel Institute (CRSI) - Manual of Practice
 - 1) CRSI 63 - Recommended Practice for Placing Reinforcing Bars
 - 2) CRSI 65 – Recommended Practice for Placing Bar Supports, Specifications and Nomenclature
 - 3) Manual of Standard Practice
- j. Eslon Engineering Manual for Plastic Piping Systems
- k. Federation International de Natation (FINA) (www.fina.org)
- l. International Association of Plumbing and Mechanical Officials (IAPMO) (www.iapmo.com)
- m. IEEE - Institute of Electrical and Electronics Engineers
- n. IPCEA - Insulated Power Cable Engineer's Association
- o. ISO – International Organization for Standardization
 - 1) ISO-10352 - Fiber-reinforced plastics
 - 2) ISO-1172 - Textile-glass-reinforced plastics
 - 3) ISO-12114 - Fiber-reinforced plastics

- 4) ISO-2577 - Plastics - Thermosetting molding materials
- 5) ISO-1183A - Plastics -- Methods for determining the density of non-cellular plastics
- 6) ISO-14125 - Fiber-reinforced plastic composites
- 7) ISO-179 - Plastics -- Determination of Charpy impact properties
- 8) ISO-527-4 - Plastics -- Determination of tensile properties
- p. LATICRETE Technical Guide for Swimming Pools, Fountains, and Spas
- q. MSS - Manufacturers Standardization Society:
 - 1) MSS-SP58 - Pipe Hangers and Supports - Materials, Design, and Manufacture
 - 2) MSS SP69 - Pipe Hangers and Supports - Selection and Application
- r. MET – Met Laboratories, Inc.
- s. Model Aquatic Health Code
- t. National Association of Architectural Metals Manufacturers (NAAMM)
 - 1) NAAMM AMP-500 Metals Finishes Manual for Architectural and Metal Products
 - 2) ANSI/NAAMM A202.1 (MBG-531) Metal Bar Grating Manual
- u. National Collegiate Athletic Association (NCAA)
- v. National Federation of State High School Associations (NFSHSA)
- w. National Plaster’s Council “Pool Plaster Technology.”
- x. NEC - National Electrical Code
 - 1) NEC Article 300.50 – Underground, Underwater, & Wet Locations
 - 2) NEC Article 310.10 – Underwater & Wet Locations
 - 3) NEC Article 680 - Swimming Pools, Fountains, and Similar Installations
- y. NEMA - National Electrical Manufacturer’s Association
 - 1) NEMA MG-1 -- Motors and Generators.
- z. NFPA - National Fire Protection Association 70 - National Electric Code
- aa. NSF 50 - Circulation System Components for Swimming Pools
 - 1) Recirculation and treatment equipment such as filters, recessed automatic surface skimmers, ionizers, ozone generators, disinfection feeders, and chlorine generators must be tested and approved using the NSF/ANSI Standard 50, Circulation System Components and Related Materials for Swimming Pool, Spas/Hot Tubs, which is incorporated by reference.
- bb. NSF/ANSI 61 (2010) Drinking Water System Components-Health Effects
- cc. TCNA (Tile Council of North America) - Handbook for Ceramic, Glass, and Stone Tile Installation - 2016
 - 1) TCNA 759 – Dry Set Mortar
- dd. UL - Underwriters Laboratories (or equivalent)
 - 1) UL 1081 - Swimming Pool Pumps, Filters, & Chlorinators (brominators)
- ee. United States Army Corps of Engineers (USACE):
 - 1) Concrete Research Division, Handbook for Concrete, and Cement
 - 2) CRD-C 527 – Corps of Engineers Specifications for Polyvinyl Chloride Waterstop
- ff. United States Swimming (USA Swimming)

gg. USEPA UVDGM- U.S. Environmental Protection Agency Ultraviolet Guidance Manual
hh. World Health Organization - Guidelines for safe recreational water environments

1) Volume 2 - Swimming Pools and Similar Environments

3. Specific mention of code or standard is to bring attention to that standard.
4. Any apparent silence of the Specification as to any, or the omission from them of any item, description, or a point, must be regarded as that only the most suitable general practice for the concerned item, description, or point be used.
5. Items or materials that have not been individually specified must, at a minimum, achieve compliance with the relevant code or standard where applicable.

1.07 MANUFACTURERS AND SUBSTITUTIONS

A. PRE-REQUISITES FOR SUBSTITUTIONS

1. The naming of a brand or manufacturer in these Specifications strictly establishes the quality and performance standard for the specified component/equipment. The Contractor must not switch or substitute specific brands or switch or substitute the specified manufacturer/fabricator unless This Engineer provides prior written authorization.
2. Due to the specialized nature of individual components required for this project, these specifications, in some instances, refer to various components by trade or manufacturer's name.
 - a. Whenever a proprietary (trade) name is used within this Specification Section, it is used for informational purposes to describe a quality standard of the required function, dimension, and appearance.
 - b. References to materials by trade name, make, or model number is provided to set a quality standard and must not be construed as limiting competition.
3. Prohibited fountain equipment includes that which is manufactured in China, India, and Southeast Asia. Such equipment is dis-allowed and prohibited from consideration or use by the Contractor.
 - a. All fountain equipment manufacturers must submit a certified letter signed by the President or Chief Operating Office certifying that none of their submitted equipment originated nor manufactured in the noted geographical areas above.

B. SUBSTITUTIONS

1. Provide assemblies, products, and model numbers as specified without exception. Any substitution requests must follow the procedures outlined in Division 01 documents.
 - a. Substitutions that are not equivalent or do not result in substantial cost savings for the Owner / Client are dis-allowed/prohibited.
 - 1) However, if a possible substitution might result in substantial cost savings for the Owner and This Engineer determines that the product substitution is acceptable and substantially equivalent to the specified product, the substitution may occur with This Engineer's written approval.
 - 2) Such substitution approval is subject to the Contractor officially reducing their fee or a documented payment/refund to the Owner.

- b. Do not proceed with the possible alternate or substitution unless This Engineer provides the prior written approval. Substitution requests must be made in writing and approved before bidding by the Contractor using the appropriate substitution request forms provided under the project manual's substitution section.
 - 1) Potential alternates/substitutions are limited to manufactured products having a proven history with a consistent record of successful performance.
 - 2) Due to the specialized nature of specific components required for this project, these specifications, in some instances, refer to various elements by trade or manufacturer's name.
 - 3) Whenever a referenced proprietary (trade) name is used within this Specification Section, it is expressly used for informational purposes to describe a standard of necessary function, dimension, appearance, and quality. References to materials by trade name, make, or model number are not intended to limit competition but assist in assuring high quality. Bidders are required to incorporate in their Base Bid only the named manufacturer.
- c. Other systems considered must be subject to a Contractor-provided complete set of shop drawings and specifications detailing such equipment about this project submitted for evaluation fourteen (14) days before the bidding. The submission should include a list of five (5) operating installations within a reasonable distance of the job site, complete with individuals' names and contact information.
 - 1) The list should include the names, email addresses, and telephone numbers of the operating personnel.
 - 2) The submittal's technical contents must include electrical & hydraulic calculations, equipment fabrication details, if applicable, the filter room layout in plan and elevation views clarifying the project, warranties, installation, and operating instructions.
- d. This Engineer must acknowledge/provide approved substitution of equivalent products meeting the bidding documents' terms and conditions only by written addendum. Assuming further refunds and price reductions to the Owner, additional equivalent product substitution requests may only occur within the initial 10 days after selecting the Contractor.
 - 1) This Engineer may provide written approval for such an approved substitution only after certified verification of the Contractor's fee reduction or the Contractor writing a refund check to the Owner.

1.08 SUBMITTALS

A. GENERAL:

- 1. Refer also to provisions of Division 1 - "General Conditions" for Submittal Requirements.
- 2. Partial or incomplete submittals are disallowed.
- 3. Submit one set of digital PDF's for shop drawings, catalog pages, manufacturer's sales literature, & specification sheets.
- 4. Product Data: The Contractor must provide the Manufacturer's data sheets on each product to be used, including:
 - a. Manufacturer's Preparation instructions and recommendations.

- b. Manufacturer's installation methods.
- 5. Provide detailed shop drawings of the specified equipment indicating the dimension, material of the strainers, pumps, filter tanks, valves, actuators, filter system(s) automation controller, accessory components, chemical controllers & chemical sterilizer equipment, and related equipment.
 - a. Provide a complete set of operation and maintenance manuals, engineering Drawings, and brochures for fixtures, equipment, fabricated items, and materials.
 - b. Provide a complete set of filter & operating instructions, embracing the operational functions and recurring maintenance processes involved with the complete filtration system.
 - c. Refer to Division 01 for additional submittal requirements.
- 6. Do not order, purchase, fabricate, or install any equipment without Reviewed Shop Drawings from This Engineer.
 - a. Checking is to determine general conformance with the design concept of the Contract Documents.
 - b. The Shop Drawings or submittals process must not modify the design intent of these Drawings.
 - c. Any action shown is subject to the requirements of the Contract Documents.
 - d. Contractor's means, methods, & responsibility include:
 - 1) Confirmed allowance for finishes, dimensions, and coordination at the site
- 7. Product Handling:
 - a. Delivery: Deliver new materials to the Project Site in the manufacturer's original unopened shipping containers with all labels intact and legible.
 - b. Storage: Store materials undercover to prevent damage and store only the Project Site's specified materials. Site storage and handling requirements must comply with the Manufacturer's recommendations without exception.
 - c. Protection: The contractor must use all means necessary to protect equipment before, during, and after installation and protect the installed Work of all other trades.
 - d. Replacements: In the event of damage to the packaging or materials, immediately make all repairs and replacements necessary upon reviewing the Owner's representative.
- B. SHOP DRAWINGS:
 - 1. The drawings accompanying this Technical specification are diagrammatic and show the general arrangement of equipment, piping, ductwork, services, supports, and similar related equipment. Because of the small scale within the drawings, it is impossible to show offsets, fittings, and accessories that may be required.
 - a. The Contractor must carefully investigate his work's structural and finish conditions and arrange such work accordingly; furnishing fittings, pipes, valving, supports, testing apparatus and equipment, and various accessories required to meet such conditions.
 - b. Where conditions necessitate a rearrangement, the Contractor must obtain This Engineer's prior written approval.

2. Submit shop drawings for equipment (including control panels) for this Engineer's favorable review of shop drawings, which is mandatory before the Contractor proceeding with fabrication. Shop drawings must not be "doctored" reproductions of Architect/Engineer/Owner's drawings.
 - a. The Contractor must include the proposed locations of all pipe hangers and supports.
 - 1) Pumps' piping supports:
 - a) Pipe supports located upstream of the pump and located downstream of each pump must be provided by the Contractor.
 - b) Each pump's piping must be supported fully to prevent pressures or tensions on the pumps and allow the removal of the entire pump assembly without securing or supporting the adjacent piping.
 - 2) Chemical Equipment piping supports:
 - a) Pipe supports located upstream of each chemical assembly and located downstream of each chemical assembly must be provided by the Contractor.
 - b) Each chemical assembly's piping must be supported fully to prevent pressures or tensions on the chemical assembly(s) and to allow the removal of the entire chemical assembly without securing or supporting the adjacent piping
 - b. The Contractor must incorporate the final electrical conduit diagrams, junction boxes, & pull boxes (including the corrected quantity and sizes of each conduit and junction boxes).
 - 1) Observe the NEC requirements for open conduit space during & after conductors' installation.
 - 2) When an additional quantity of conduits or enlarged conduits is needed to maintain the code-required conduits' empty-space, the Contractor must submit an RFI with a proposed solution. Following the contractor's required submittal, this Engineer must respond via a written direction document.
 - 3) If enlarged or additional junction boxes are required, the Contractor must submit an RFI with the proposed solutions. A minimum requirement includes a Contractor's certification that only Wago splice-connectors & terminations are utilized in junction boxes and panels.
3. Provide shop Drawings, at 1/4-inch=12-inches scale, including sufficient engineering data, indicate working & erection dimensions, incorporate electrical characteristics, show locations at which materials & equipment are required for installation, manufacturer-supported, other related essential data.
 - a. Provide a written manufacturer-confirmation of the product's suitability and required details.
 - b. Specialty Designated Engineering drawings (signed and sealed by a licensed **Florida** Professional Engineer) for:
 - 1) electrical,
 - 2) lifeguard & safety plans,
 - 3) stairs/landings, elevated & on-grade platforms with stairs, & detailed wind load calculations
 - 4) wet play assemblies,

- 5) water feature above-grade installations, & detailed wind load calculations
 - 6) FRP Above-Grade collector and surge tanks,
 - 7) HVAC & related dehumidification components & systems,
 - 8) heater ducting, venting, & exhaust systems for this work, and
 - 9) Each Specialty Designated Engineers must submit a professional resume demonstrating and certifying ample experience and confirm that the Specialty Designated Engineers have the expertise within their specific specialty area(s).
 - 10) A certificate of insurance listing the Owner, Architect, and ADE as an additional insured must be provided with each resume and must include a minimum of:
 - a) General Liability: \$1,000,000 / \$1,000,000
 - b) Workers Compensation: Statutory
 - c) Professional Liability: \$1,000,000 / \$1,000,000
 - d) Exception: Professional Liability policies are exempt from the additional insureds' requirements
4. Shop Drawings must indicate the following:
- a. Submit shop drawings detailing the installation methods. Coordinate placement with locations noted in the Contract Drawings.
 - b. Existing conditions - a site examination by a knowledgeable representative is mandatory to be followed by a contractor-generated report documenting the existing conditions to be impacted by construction & implementation of the Contract Documents.
 - 1) The Shop Drawings' submittal affirms that the Contractor has acknowledged his acceptance of the existing conditions and that the Shop Drawings were adapted, created, and originated based upon the Contractor's existing-conditions-knowledge.
 - 2) The Contractor must confirm the ceiling heights within the pool equipment room to confirm the required equipment's installation's clearances.
 - c. "Dead-line" (dewatering pipe outlet) locations. Dewatering includes:
 - 1) cold-weather winterization and freeze-prevention piping, auto-draining conduit, and piping assemblies to a low spot to facilitate the evacuation of all collected moisture & water, related water sumps, and its pumps.
 - 2) Dewatering and freeze-protection is a Complete Build Activity. Refer to COMPLETE BUILD SCENARIO OVERVIEW
 - d. Piping elevations, locations, routing, and slopes
 - 1) Graphically illustrate individual pipes with their identification and sizes
 - e. Pipe trench elevations and locations illustrating minimum excavated earthen slopes (after coordination with other Contractors)
 - f. Tank ballast and anchor-type concrete
 - 1) Submit anchoring details (attaching the collector/reservoir/surge tank to the concrete ballast pad and mass) for approval before installation.
 - 2) Incorporate the manufacturer's anchoring, installation recommendations, and support requirements within the shop drawings.
 - g. Pre-cast tanks or similar structures

- h. Handhold details and dimensions on pool walls without an open gutter or recessed-gutter beam edge must be compliant with the local governmental hand-hold requirements and the Contract Documents' requirements.
- i. Indicate compressed air systems and air blowers' metallic-piping diagrams, shop drawings, and components' arrangements within the submittals and shop drawings.
- j. Submit the shop drawings for the fabricated control panels. The shop drawings must indicate the circuitry, relays, PLC's with required programming, all necessary components, transformers to complete the connectivity to each component illustrated & listed in This Engineer's documents.
 - 1) Control Panels' shop drawings, fabrication, programming, & related equipment is a Complete Build Activity. Refer to COMPLETE BUILD SCENARIO OVERVIEW
- k. Provide required hardware, conveyors & stands, fulcrums, required reinforced concrete footers & foundations, concrete foundations, concrete wet decks/pads, communication signaling, operator instructions, safety recommendations, entry & exit safety signage, operator guidelines, and operator training documents especially suitable for this project for:
 - 1) Slides, conveyors, related assemblies, & detailed wind load calculations
 - 2) Water Play, Wet-Play, and Water-Activity assemblies, components, related structures, water-type toys, & detailed wind load calculations
- l. Piling designs. Refer to COMPLETE BUILD SCENARIO OVERVIEW

C. PRODUCT DATA

- 1. Manufacturer's literature and data indicating performance characteristics, rated capacities, weights, materials, surface finish, accessories, electrical nameplate data, wiring diagrams.
 - a. Submit for review all certificates of conformance with specified codes and standard Contract Documents.
- 2. Provide data on the following equipment, lighting, and accessories:
 - a. Equipment room equipment:
 - 1) Pumps and motors, including manufacturer-supplied performance curves at the flow and pressures to include the following minimum requirements:
 - a) Pump compliance with specified epoxy-fused coatings
 - b) Stainless steel shaft
 - c) EPDM seals
 - d) Hair and Lint Strainer (if integral)
 - e) Compliance (or equivalency) with a national listing agency
 - f) Self-priming pumps must include the mandatory manufacturers' certification for water-lift capabilities surpassing those required for this project. Self-priming pumps more substantial than 0.75-hp must include automated self-priming assist connections, equipment, valves, and materials connected to the potable water supply. Refer to COMPLETE BUILD SCENARIO OVERVIEW
 - 2) On pump motors, include specific:
 - a) The manufacturer confirmed VFD-Duty certification

- b) Documented certification for premium efficiency. NEMA Premium (12.12) for Imperial and IE3 if Metric.
 - c) Insulation description and rating
 - d) A minimum TEFC-type enclosure or an approved equivalent. Open Drip-Proof (ODP) motors are dis-allowed unless allowed explicitly by This Engineer
 - e) Manufacturer-approved rain guards for each pump motor(s) located in outdoor conditions.
 - 3) Chemical & equipment rooms include documentation for specific:
 - a) controllers, chemical safety (dual-wall) safety tanks (with accessories), chemical feeders, UV sterilizers, saline generators, and specified chemical supply hoses, labels, conduits, sleeves, labeling, & related materials.
 - 4) Variable Frequency Drive (VFD) physical sizes, allocated electrical loads, and noted compliance with specified programming features.
 - a) Indicate mandatory integration with the Defender Filter's Regenerative Media Filter (RMF) and UV system(s) de-activation of related pumps when UV performance degrades.
 - 5) Motor starters with soft start feature.
 - 6) Filters with automation equipment, including all components and related sub-assemblies.
 - a) Metallic components for compatibility with the total immersion in basins containing mild saline water, salt-air proximity, and seawater exposure.
 - b) Submit to This Engineer certified test results within 7 days of the verification water-testing date.
 - 7) Fossil-fuel heaters: include written verification of the available, tested on-site gas pressure & type of gas.
 - 8) Heat pumps
 - a) Include heating times from start-up to desired water temperatures
 - b) Adequate ventilation and maintenance clearances per the manufacturer's requirements
 - c) Electrical and disconnect requirements
 - d) Water supply & discharge requirements
 - 9) Chemical storage safety tanks with factory-provided penetrations, fluid-level system, & permanent labeling
 - b. Vapor-retardant pool covers
 - c. Link-Seal (with Century Line thermoplastic wall sleeves) waterproof piping penetration assemblies including 316L stainless steel hardware
 - d. Water stops (No-Leak water stops, pre-fabricated water stops, water stop fittings, & metallic water stops)
3. Complete Build Specialty Designated Engineering submittals with sign & sealed documents:
- a. These are Complete Build activities.
 - 1) Ventilation fan systems, exhaust systems, & ceiling/floor-level intake/exhaust-venting systems assemblies.

- 2) Water activities, water features, wet play components.
 - a) Include wind load calculations for each above-grade structure for local governmental approvals by the Contractor's delegated specialty engineer.
- 3) Plate Heat Exchangers' Materials: Titanium
- 4) Heater ducting, exhaust hood, exhaust vents, barometric dampers, and related dual-wall safety ducting, flue, and exhaust/venting systems
- 5) Coordination with the Project's Structural Engineer to obtain written approval for piping hangers, supports, braces, and expansion components that are supported by the building's floor, wall, or ceilings
- 6) Electrical power systems, Control Panels & related-systems, and lighting control panels including, but not limited to:
 - a) Control wiring and light schematics and componentry
 - b) Under-deck, underground, underwater, wet-rated conductors, and similar wires to include rigid & flexible conduits
 - c) Auto-Fill/water level controls, wind velocity controls, solid-state, Ground-fault-circuit-interrupters (relays) for all submersible pumps
 - d) CAT 5E minimum, although CAT 6 and 6A type data cables are acceptable for under-deck, underground, and underwater rigid & flexible conduits (must be rated as suitable for wet conditions).
 - e) Equipment room electrical panels must show the code-specified 36-inch to 48-inch [1.22 m] uninterrupted clearance in front of panels, motor starters, VFD's, transformers, disconnects, power supplies, automation panels, & similar equipment. Verify the necessary clearances to meet local codes.
 - f) Underwriter's Laboratories (UL)-listed pressure-type or exothermic weld (in compliance with NEC) for ground wires' and earthing connections.
 - g) Caution: Rejection must occur if the confirmed, correct electrical power supply is absent in the documents.
4. Deck-located equipment:
 - a. Rail products and Accessible Lift Units:
 - 1) Manufacturer's welded rails & components, including rail goods, handrails, ladders, grab rails, inset steps, and Accessible Lift Units (ALU).
 - a) Show details of the below-grade concrete-mass-anchors to be provided when there is no concrete decking.
 - b) Indicate anchor locations with dimensions.
 - c) Ladder submittals must indicate the relative location of the water level as compared to the uppermost ladder tread. The upper-most ladder tread must be located underwater.
 - d) Show vertical supports' spacing on rails and cross-bracing (with clearances above the coping and bottom step).
 - e) Provide capacity loads and seismic certifications for each Accessible Lift Unit.
 - b. Deck-located rinse shower assembly with drinking water fountain including ADA compliant operators
 - 1) Provide the same submittals to the Architect and Landscape Architect

- c. Zero-entry type and rim-flow type fiberglass trench materials and parallel style grating with a locking feature (to the trench) to prevent unauthorized access to the trench below
- d. EVA-rubber copolymer tile wet area surfacing system:
 - 1) Product Data: Submit manufacturer's product data and installation instructions.

D. COLORS / SAMPLES:

- 1. Submittals for color and texture approvals of Contractor-provided samples include, but are not limited to:
 - a. Interior finishes
 - 1) The interior pool finish coating must incorporate/display a dry lightness level (CIE L value) of 80.0 or greater. Further, it must include a wet luminous reflectance value (CIE Y value) of 50.0 or greater, as determined by test results provided by the manufacturer, utilizing testing methodology from American Standard ASTM D4086, ASTM E1347, & ASTM E1477.
 - 2) Slip-resistant finish rating from the manufacturer
 - b. UV inhibitor coating on "exposed to sunlight" CPVC & PVC (& similar petrochemical piping)
 - c. Refer to the Landscape Architect's documents for the following:
 - 1) Textured, non-slip, & impervious Decking
 - 2) Deck drainage components and materials
 - 3) Wet play components for color and texture selections
 - 4) Tiles and stone finishes, including epoxy flex joints and grouts, and similar materials.
 - a) Non-Slip tiles for horizontal surfaces (refer to Drawings' finish schedule)
 - b) Glazed tiles for vertical surfaces (refer to Drawings' finish schedule)
 - c) Epoxy grouts suitable with the setting materials
 - d) Colors & textures for tiles and grout
 - d. Metallic primers and topcoat paint materials
 - e. EVA-rubber copolymer tile wet area surfacing system:
 - 1) Submit the color and samples as noted in the Drawings
 - 2) Submit manufacturer's standard verification samples of 24" x 24" minimum.

E. BASIN ITEMS:

- 1. The angle of repose excavation diagrams and shop drawings
- 2. Dewatering
- 3. Vapor barriers
- 4. Steel Reinforcement (Rebars)
 - a. Submit shop drawing, bending, detailing, and fabrication drawings on rebars before purchase and fabrication.
 - 1) Include material, grade, bar schedules, stirrup spacing, bent-bar diagrams, arrangement, and concrete reinforcement support.

- 2) Incorporate enhanced, special reinforcement required for openings & penetrations through waterproof concrete structures.
5. Basin structural concrete & shotcrete
 - a. Exception: Refer the appropriate submittals to the Architect, Civil Engineer, MEP Engineer, HVAC Engineer, Structural Engineer, or Landscape Architect if they are the design professionals for these components
 - b. Submit written reports to This Engineer of each proposed mix design for each concrete type at least 15 days before commencing construction. Do not begin concrete installation until This Engineer reviews design mixes.
 - 1) Identify and label each mix design as being for basins, decks, or ballast-type concrete anchors
 - 2) The ready-mix supplier must coordinate with Xypex to warrant the proper type. The dosage of Xypex Admix is provided based on, but not limited to, the specific products used in the mix design and the conditions at the job site. Provide a written confirmation that this coordination has taken place (in the same submittal package as the concrete mix designs).
 - c. Submit the following information:
 - 1) Listing of the aggregates and their source of supply.
 - 2) Recent testing of aggregates for compliance with specified requirements.
 - 3) Scale weight of each aggregate(s).
 - 4) Absorbed water in each aggregate(s).
 - 5) Brand, type, and composition of cement.
 - 6) Brand, type, and the amount of each admixture.
 - 7) Quantities of water used in trial mixes.
 - 8) Provide documentation showing the recycled content (fly ash, aggregates, and other additives by weight) of the concrete.
 - 9) A listing of included proportions of each material per cubic yard, including fibrous secondary reinforcement.
 - 10) Gross weight and yield per cubic yard of trial mixtures.
 - 11) Measured slump.
 - 12) Measured air content.
 - 13) Compressive Strength Tests:
 - a) ASTM C39; one set for every 100 cubic yards or fraction of each mix design placed in a day or for each 5,000-Square Feet of surface area for a basin's floor and wall.
 - b) Make 5 (4-inch x 8-inch [100 x 200 mm] cylinders) laboratory-cured specimens. Test one specimen 7-days after collection, test three specimens 28-days after collection, and test one specimen (retained in reserve) for later testing if required.
 - c) Historical test reports may be from previous projects within the past 6-months.
 - 14) Create a test panel for Shotcrete (wet-mix) testing cores.
 - 15) Identification number or name of mix to verify agreement with compression test reports

- 16) Submit laboratory test reports for waterproof concrete materials and mix design tests.
- 17) Submit material certificates instead of materials' laboratory test reports when permitted by Architect.
 - a) The manufacturer and Contractor must sign material certificates, certifying that each material item complies with or exceeds specified requirements.
 - b) Provide certification from admixture manufacturers that chloride content complies with specification requirements.
- 18) Submit the meeting minutes of the pre-installation conference.
- 19) Submit proposed mix designs that meet or exceed the requirements of the Contract Documents.
- 20) Submit a statement from a ready-mixed plant verifying conformance to specifications and proposed mix designs.
- 21) Submit written approval/certification of concrete curing materials as specified herein.
- 22) Concrete curing materials and adhesives for finishes must be compatible.

6. Waterproofing Systems & Waterstops Description

- a. A concrete waterproofing system must be of the crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure throughout the concrete's capillary voids. The waterproofing system must cause the concrete to become sealed against liquids' penetration from any direction and protect the concrete from deterioration due to harsh environmental conditions.
- b. Waterproofing cementitious materials data sheets
- c. Waterproofing admixes materials data sheets
- d. CPVC & PVC & pre-formed plastic water stops
- e. Adhesive & hydrophilic water stops

7. Concrete admixes

8. Concrete anchoring specialty products

- a. Anchoring details (attaching the collector/reservoir/surge tank to the concrete ballast pad and mass).
- b. Rated capacities for anchors and attachments
- c. Incorporate manufacturer's recommendations & requirements for anchoring, backfill, and drainage installation best practices.

9. Concrete patching, topping, and rehabilitation materials

10. Expansion/construction joint materials

11. Non-Shrink grouts

12. Caulking / Sealants / Deck to Beam Sealant

13. Underwater Sealants

14. Coping & tile adhesives and setting materials

15. Dowel and dowel sleeves

16. Specialty fabricated joint fillers & primers

F. EQUIPMENT ROOM & SITE ITEMS:

1. Piping, piping cement, glue, cleaners, primers, valves, fittings, supports, and hangers – for the entire project.
 - a. Flexible piping connectors
 - b. Specialty piping, eccentric and other reducers, and fittings
 - c. Piping Manifolds
 - 1) Provide thoroughly dimensioned shop drawings and indicate all flanged connectors.
 - 2) Provide anchoring details for manifold supports
 - 3) Below-grade enclosures for outdoor-located manifolds
 - d. Valve and piping tagging, with a color-coded I.D. system and corresponding valve chart
 - 1) Submit two (2) copies of laminated 18-inches x 24-inches [455mm x 610mm] valve charts for each piping system, consisting of Isometric Drawings or piping layouts showing and identifying each valve and describing its function to This Engineer for prior approval. The valve chart must be suitable for mounting in the equipment room.
 - e. Valves, check valves, valve operators, flanges, and flange hardware
 - f. Modulating valves (with level-sensing controls) for the collector/reservoir/surge tank.
 - 1) Note: Provide each surge tank with the safety, normally-closed electrically-operated butterfly shut-off valve, electronic control, & sensors to confirm a positive seal to prevent an increase of water to the surge tank when the pumps are de-activated.
 - a) Valve operator/controls must be mounted to be above the surge tank water level without exception.
 - b) Normally-closed, fast-closure butterfly valves are mandatory to achieve a 100% valve closure when a loss of power is detected.
 - c) All modulating butterfly type valves must also be accompanied by a manual-gear-operated butterfly valve upstream of the modulating valve.
 - g. Gauges, meters, thermometers, and sensors
 - h. If Type 6 (galvanized steel) piping is proposed or specified:
 - 1) indicate its intended purpose
 - 2) Cut sheets for the required chlorine impervious coating.
 - i. Water hammer arrestor devices, reduced pressure assemblies, & backflow preventers
2. Pumps
 - a. Submit all manufacturer cut sheets and catalog descriptions, including performance curves with the targeted flow and TDH noted on each submittal.
 - b. Submit exploded assembly of components with their materials used for:
 - 1) pump casing and its epoxy-fused coating
 - 2) materials incorporated within the pump's wet-end, including:
 - a) Pump shaft material

- b) Impellor materials
 - c) Integral pump strainer (hair & lint strainer including the openings within the strainer basket and strainer materials
 - d) Grounding lugs for bond & earthing compliance
 - e) NSF-Standard 50 certification
- c. Submit all electrical motor cut sheets and catalog cuts to identify the Hertz, Phase, voltage, Full Load Amps, VFD-Duty certification, connection lugs, bolt-on connectors, & pump's wiring insulation.
- d. Submit all mechanical seal and pump bearing data, cut-sheets, & information
- 3. Water-Spray nozzles
 - a. Provide written certification for each nozzle's demonstrated operation.
- 4. Coping and interior finishes – non-slip surfaces are mandatory.
- 5. Depth markings, "NO DIVING," and other marking tiles - (non-slip surfaces required on horizontally-located markers)
- 6. Floor Access Doors with safety ladders
- 7. Pool Rules and Safety signage
 - a. The Client/Owner must approve the contrasting colors, lettering, 1-inch [25 mm] minimum lettering height, text content, font, and finish materials before the Contractor purchasing signage.
 - 1) Refer to the Drawings for required minimum rules
 - 2) The words "NO DIVING" must be in 4-inch [100mm] high lettering
 - 3) The maximum pool water depth must be posted on the Rules signage
 - 4) There is no provision for drink or food serving facilities within 12-feet [3.65 m] of the water's edge.
 - 5) The Owner may add additional rules
 - b. Refer to the Slide & Wet-Play manufacturers for the specific lifeguard & safety plan, safety signage for their products & units.
 - 1) Similarly, required signage is due from manufacturers for Slides, Wet-Play equipment, Water-Toys, and similar products & services.
 - 2) The Contractor-provided lifeguard and safety plan must meet the local governmental agency's requirements before completing activities, substantial completion, & operating permits' issuance.
 - c. All safety signage must be illuminated and easily read if the site is used at night
- 8. Restroom location directional signage
- 9. Color printed sample representations (actual size) of the labeling and valve tags specified herein.
- 10. Details of assembly and installation for deviations from the Drawings.
 - a. Submit laboratory confirmation (using the positive analytical method) of adhesives, admixes, mortars, epoxy grouts, and other installation materials:
 - 1) Identify the proper usage of the specified materials.
 - 2) Identify the compatibility of specified materials.
 - 3) Identify proper color matching of specified materials.

4) Identify chlorine ions contained in concrete admixes

11. Industrial Ground Fault Circuit Interrupters for each submersible pump.

12. Chemical hoses/tubing as per the requirements herein.

G. MOCK-UPS ON-SITE:

1. One mock-up panel being a minimum of 3-feet [0.91 m] long illustrating pool deck edge(s), gutter surfaces, zero-entry trenches, and lockable grating (when specified), rim-flow edges, and deck drainage equipment.
 - a. Without exception, complete all mock-up panels within 30-days from contract execution and permit issuance.
2. Provide artistry & attention-to-detail to each Mock-Up assembly about:
 - a. The finishes, color, texture, and non-slip/slip-resistant ratings
 - b. Tiled depth markings
 - c. Tiled "No Diving" lettering group,
 - d. International "No Diving" symbol tiled with Red-Color marking
 - e. Utilize this mock-up panel for Shotcrete testing.
 - f. Demonstrate that water-level sensitive edges & trims (the gutter-edge & lip, infinity edge, and weirs) are precisely level
 - 1) Exception: The maximum variance from the highest point to the lowest point must not exceed 0.125-inches [3.17 mm].
 - g. In the event of grating within the mock-up, include adjacent finishes, adjacent underwater lights, grate mounting hardware, and components visible around and within the mock-up space. Maintain a targeted 0.375-inch space gap between the finished wall and deck edges to assist in water passing around or through the grating with minimal water splash.
 - h. All metallic components must be safe and not contain sharp edges or similar characteristics that might cause cuts, injury to bathers, guests, patrons.
3. Cast mock-up of the size indicated or required to demonstrate typical joints, form tie spacing, spacing gaps to allow water to pass with minimal water splash, and proposed surface finish, texture, and color. Maintain sample mock-up panel exposed (but protected) to readily-accessible viewing for the duration of the Project after Architect & Owners accept visual qualities.
 - a. Demolish mockups/panels and remove them from the site when directed by the Architect or This Engineer.

H. APPROVAL / INSPECTION / SCHEDULES DOCUMENTS

1. Schedule of Values:
 - a. Provide This Engineer a copy of the Schedule of Values developed for this project relevant to Section 13 1100 for written approval.
2. Provide written approvals, a record of successful inspections, and completed operating permits for the following governmental agencies:
 - a. Building Official and Building Department(s)
 - b. Department of Health

I. QUALIFICATION DOCUMENTS PROVIDED WITHIN THE BIDDING PROCESS

1. Contractor and Commercial Pool Installer qualifications (required with bid submittal):
 - a. Submit a copy of the Florida Contractor's License (applicable to all license holders) with the bid documents.
 - 1) A minimum of one person in the firm must be a Florida Licensed Contractor whose license qualifies the firm for the Contract Documents' work scope.
 - b. Submit listings of five previous similar projects to the Owner with the Client's contact information.
 - 1) Each submitted project must include a narrative of the completed project, the approximate construction costs, and the date that the project was completed.
2. After the bidding process is completed, the selected Contractor or Commercial Pool Installer must provide the name and qualifications of the Contractor's Specialty Delegated Engineer(s) proposed for use on this project.
 - a. All delegated engineer(s) must be a Florida Licensed Professional Engineer with the qualifications and professional work experience resume to match the proposed design scope (if necessary) proposed by the selected Contractor or Commercial Pool Installer.
 - b. The required Contractor's Specialty Delegated Engineer(s) on this project include:
 - 1) Testing Professional Engineer for density, compaction, and related soils evaluations
 - 2) Dewatering Professional Engineer for the dewatering expertise.
 - a) The selected Contractor or Commercial Pool Installer may, at his option, select and present a Specialty Dewatering Contractor licensed by the State of Florida and with expertise and work/professional resume that substantiates their expertise.
 - b) This Engineer and the Owner must approve the use of these Specialty Designated Engineer(s) (or specialty Florida Licensed Contractors with a proven, documented resume) and insurances that comply with the Owner's insurance requirements.
 - 3) If the selected Contractor or Selected Commercial Pool Installer does not provide the names and qualifications of the Contractor's Specialty Delegated Engineer(s) proposed for use on this project, or if the Owner and This Engineer reject their resume or qualifications, then this may be used as cause, grounds, or reason for the disqualification of the apparent, selected bidder.

J. OPERATION & MAINTENANCE (O & M) DOCUMENTS

1. Provide thorough instructions & operating manuals to the pool operator via this submittal process. Before turning over to the operator/owner, the Contractor must provide the comprehensive operating manuals to This Engineer for review and approval. At a minimum, include in the manuals:
 - a. Written instructions for total operation & maintenance of each system
 - b. Comprehensive valve charts and schedules
 - c. Include specific valve operating directions for the following functions:

- 1) Normal filtration
- 2) Backwash events
- 3) Filter cleaning events
- 4) Basin draining events
- 5) Piping manifolds are labeled and identified by function on the wall-mounted chart (enclosed in waterproof enclosures).
- d. Manufacturer-issued "owner operating & maintenance manuals" and warranties
- e. A written contact list of the applicable Contractors' employees (names, phone numbers, and email addresses)
- f. A written list of each manufacturer's local representative (or the contact person's info at the actual manufacturer) with names, phone numbers, and email addresses.
- g. A copy of each submittal document with the engineer's review stamp affixed
2. Provide the Operations and Maintenance (O & M) Manual
 - a. The Contractor must deliver to the Architect/Engineer/Owner an electronic copy of the O&M Manual submittal for review and approval, and a Final Approved O&M Manual. Once approved, O & M Manual must also be provided in hard copy bound format, to include four (4) sets each.
 - b. O&M Manual must contain operating and maintenance instructions for the pool basin structure(s), finishes, and component equipment including, but not limited to, the following:
 - 1) Table of contents.
 - 2) Equipment cut sheets.
 - 3) Control Panels
 - 4) Accurate parts list.
 - 5) Pool start-up, commissioning, and emptying-of-basins' water instructions.
 - 6) Pool cleaning, chemical re-supply, and maintenance instructions
 - 7) Auto pool cleaner operation & maintenance
 - 8) Pool maintenance requirements, detailed and based upon: Daily, Weekly, Monthly, Seasonally, and Annually
 - 9) The narrative on the pool operations & sequences.
 - 10) Troubleshooting information and procedures.
 - 11) A piping diagram (schematic) is installed and wall-mounted.
 - a) Incorporate the updated valve I.D. & numbers for installed valves into this diagram
 - 12) Valve charts for each piping system consist of isometric drawings, piping layouts showing and identifying each valve, and describing its function.
 - 13) Record Drawings
 - 14) Warranties
 - 15) Wet Play Commissioning reports and records (as a Complete Build Activity).
 - a) Provide a listing of the various weights of the test riders and describe all incidents or safety concerns.
 - c. Provide a DVD of complete start-up and shut-down procedures as well as the training session.

3. Control systems data / info / narratives:
 - a. The scope of the project determines the various control systems' narratives specified within the operators' manual. The controls narrative must thoroughly describe each Contractor-provided electrical control system and lighting control system.
 - b. Typically included control system descriptions:
 - 1) Filter automation control must include the following modes:
 - a) Normal
 - b) Backwash (for sand filters)
 - c) Tank Drain
 - d) Addition of filter media (if applicable)
 - e) Pre-Coating (if applicable)
 - 2) Automatic water fill and water level control with an operational static pipe
 - 3) Operations with VFD to control/compliment filtration system operation and pumping flow rates
 - 4) Chemical automation control
 - a) UV-system deactivation routines to cease operation of the UV equipment.
 - b) Chemical systems' electrical interlocks with filter pump operation
 - 5) Electrical control protocols with the building management system
 - 6) Chemical operations / water level systems / flow sensor & flow switches
 - c. VFD operations and controls
 - 1) Increase and reduction of the pump rotational speeds
 - 2) Interlock and controls with:
 - a) Automated filter operations
 - b) Timeclock functions
 - c) Manual over-ride operation
 - d) Flow controls
 - e) Pressure and vacuum sensor systems
 - f) LED lighting control systems' operation
 - g) Automated nozzle control
 - h) Low-water & high-water level control systems
 - i) UV sterilizer systems
 - j) Saline chlorination generation systems
4. Equipment Certification(s) from Contractor
5. Manufacturers' "approval of installation" certificates must be provided to the Engineer for transmittal to the Owner. Certify the following documentation packages include:
 - a. Heater(s) system documentation to include:
 - 1) Ducts, dual-wall flues, exhaust, and venting assemblies and componentry (as a Complete Build Activity)
 - 2) Sensors for high-temperature and low water-flow
 - 3) Separation from upstream chemical feeders (place chemical feeders downstream of the Heater(s) and similar equipment).

- a) Piping with heated water more than 100-deg F. must be insulated and protected with a waterproof vapor barrier jacketing
 - b. Pump(s) documentation to include:
 - 1) Types A, B, C, D, E, G, AND K
 - 2) Larger than 10-hp [7.45 kW]
 - 6. Submit certified documents, including the lifeguard and safety plan to the governmental Department of Health, This Engineer, and the Owner and Architect before issuing operating permits.
 - 7. One set of the local governmental-approved Drawings (with the official approval stamps in place) with the fully signed Department of Health (DOH) forms.
 - 8. Six (6) sets Surveyor Certifications' reports (signed & sealed), records, and the official written certifications from each Swimming Agency.
- K. WATER TOYS, WET-PLAY, & RELATED ASSEMBLIES
- 1. This is a Complete-Build Activity by the Contractor.
 - 2. Before public use, a written certification of approved completion from the Specialty Designated Engineer and the water toys and wet-play structure manufacturer/vendor must be provided to the Owner to This Engineer, and the LGA.
 - a. Provide all safety instructions, safety equipment, required signage wording, training for operators (and owners & attendants), and evacuation procedures for life-safety events
 - 3. Provide digital DVD's of the operating instructions as taught to the operators and Owner's Representative.
 - a. Provide one digital DVD copy to This Engineer
 - b. Provide two digital DVD copies to the Owners / Operators
 - c. Provide an engineering certification that equipment is producing and providing the performance outlined in the Contract Documents.
 - d. Record Drawings to include, but not limited to:
 - 1) As-built locations and quantity of the hydrostatic relief device/valves within each basin
 - 2) de-watering piping access locations
- L. PERMITS, INSPECTIONS, PHOTO DOCUMENTATION, AND TEST RESULTS
- 1. The Contractor must:
 - a. Submit written copies of the approved Department of Health permits before commencing construction.
 - b. Submit inspection results within three (3) days following each inspection.
 - c. Provide the certified water test reports substantiating the required chemical properties.
 - d. Provide the photo documentation of the potting compound in place within each underwater junction box.
 - e. Provide satisfactory, successful test results for Contractor's water leak testing for all piping systems, and conduits connected to the basin and related junction boxes
 - 2. After the project startup and before project completion, the Contractor must submit:

- a. One set of completed inspection and test documents.
- b. Field reports or memos required by or submitted to regulatory agencies.
- c. Field examination & written test results for “as-installed” observed performance and operational data, including the following:
 - 1) Water flow rates as determined by the provided flowmeters
 - 2) Water pressure and vacuum gauge readings
 - 3) Motor currents (amp draw on each leg) for each pump
 - 4) Lighting circuit currents for each circuit and power supply
 - 5) Power supplies and circuits must be provided with incorporated, balanced loads.
 - a) The Contractor must provide the amps' written document schedule per circuit/power supply, noting that a maximum deviation of 5% between circuits/power supplies is allowable and not exceeded.
 - 6) Successful earthing & grounding tests on metallic equipment items around the basin perimeter and between the mechanical hardware and basin deck equipment.
 - a) Employ the use of a “sounding/ringing” test equipment (or an approved equivalent device) to confirm continuity achieved by proper bonding/earthing/grounding procedures
 - b) Certify that adjacent grounding systems are interconnected to the pool/fountain bonding/grounding/earthing system(s).

M. CERTIFICATIONS

1. General
 - a. The Contractor must pay for the costs relating to all manufacturers’ and vendor written certifications.
 - b. Each manufacturer’s written certification must certify that the equipment was installed compliant with the manufacturers’ requirements. It is operating per the intent, programming, and has required labeling with operation manuals.
 - c. Submit the successfully written certifications to This Engineer after approved observation.
2. Contractor certifications
 - a. Provide the Contractor's certification that specified products and equipment are installed and functioning per the Contract Documents.
 - 1) The contractor applied finishes to the basin(s).

N. MANUFACTURER CERTIFICATES OF INSTALLATION

1. Obtain written manufacturer’s installation certificates stating the manufactured equipment is installed according to the manufacturers' instructions & recommendations and Contract Documents.
2. The following minimum listing of equipment must have the manufacturer’s written certifications:

13 1100.xxx	Equipment	Remarks
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2.08.F & 3.08.D	ADA approved accessible lift unit devices	Operation, mounting, & adjustments
2.10 & 3.10	Pumps	All except 4 hp & smaller
2.11 & 3.11	Automated Filter Systems (includes Regenerative & Automated Sand Filters)	Not required for Pressure Cartridge or Multiport-type valved filters
2.15 & 3.15	Chemical Controllers with related chemical feed systems	Calibration required, and testing to ensure electrical interlock
2.15.D & 3.15.D	UV Sterilizer systems	Piping location, programming, & safety interlocks
2.15.E & 3.15.E	Saline Generators	Control systems & piping connections, & exhaust vents
2.16 & 3.16	Heaters, heat pumps, & plate heat exchanger systems	Confirm all ducting, exhaust, drainage, piping, type, valving, & gauges & regular operation
2.17 & 3.17	VFD's	Must include the features noted in the spec reference
2.17 & 3.17	Control Panels & their programming	
2.29.F & 3.29.F	Compressed air systems	Compressor, receiver tanks, hoses, valving, operation
2.30 & 3.30	Automated Fountain Nozzles	
2.31 & 3.31	LED Fountain Lighting, Power Supplies, & Junction Boxes	Colors are true & correct & is DMX-connected
2.32 & 3.32	Wet Play Equipment, signage, & related platforms & stairs	Optimum water flows adjusted & safety of systems

O. REVIEW OF PROJECT DOCUMENTS

1. Submit three (3) sets of "as-built" drawings (Record-Set) and one (1) set of electronic PDF files. As-Built Drawings must reflect "as-installed" deviations in red ink on the "For Construction" Drawings.
2. As-Built (Record-Set) Drawings must accurately record actual and verified:
 - a. The location and elevation of each pool basin
 - b. The horizontal/elevation locations of all conduits, pull-boxes, & transformers/power supplies
 - c. All conduit & piping locations and elevations
 - d. All conduit & pipe trenches (showing horizontal and vertical conduit/piping locations, slopes, starting invert elevations, and termination invert elevations of conduits/pipes)
 - e. All related equipment
 - f. A written description of excavation difficulties and irregularities encountered during the construction phase
 - g. All de-watering locations, pumping ports, and related access areas

- h. Electrical control panel (& systems) successful execution/installation
- i. Bonding/earthing/grounding systems] successful execution/installation
- 3. Submit 3 DVDs containing operating instructions, photos, and maintenance duties of the Owner's personnel.
- 4. Warranty and maintenance certificates
- 5. The Governmental certificate of completion of this project.
- 6. The Governmental written receipt for the Lifeguarding & Safety Plan
- 7. The Governmental-issued written operating permit for each pool basin.

1.09 QUALITY CONTROL

A. PROCEDURES

- 1. Quality Control must include the following specified procedures:
 - a. Use of qualified installers and personnel
 - 1) Commercial pool installer qualification is mandatory & required before the award of the contract bid. Submit these qualifications to This Engineer on form AIA A305 (or an equivalent).
 - 2) The pool installer must meet local and verified state certifications and license requirements before bidding. Copies of required certificates and Contractor-licenses must be made available upon request.
 - 3) Wet Play equipment erectors & installers must be pre-certified by the respective manufacturers.
 - b. Performance of work per applicable codes and standards
 - c. Hold clearance dimensions and mounting heights specified by the NEC, as recited below, & in the Contract Documents. Submit conflicts for written direction.
 - d. Perform work per the applicable municipal, county, and state codes along with applicable permits.
 - e. Wet Deck limitations & codes:
 - 1) No re-use irrigation water is allowed within 10-feet [3.05 m] of any pool or the pools' wet deck, nor can such water enter the basin or its collector tank.
 - 2) The initial 15-feet of the wet deck must extend toward the restrooms serving the pool.
 - 3) River-Ride & Slide Plunge Pool attractions: Wet decking must be provided at the entrance and exit points as necessary to provide safe patron access but must not be smaller than 10-feet (3048 mm) in width and length. Additional decking along the ride course is not required except that the wet deck must be required at lifeguard locations and emergency exit points.
 - f. Wet-Play equipment installers must be pre-certified by the respective manufacturers.
 - g. Water-level sensitive edges & trims (the gutter edge/lip, infinity edge, and weirs) must be precisely level
 - 1) Exception: The maximum variance from the highest point to the lowest point must not exceed 0.125-inches [3.17 mm]
 - h. Excellent quality of workmanship is required.

B. SOILS QUALITY, DEWATERING, & CERTIFICATIONS

1. No deflections or settlement of the soils are permissible on this project.
2. Vacate all standing water before placing concrete.
3. The Owners' Geotech must dictate the need/requirement for piers/pilings.
4. The Contractor must provide to This Engineer, the Geotech Engineer's written report(s) certifying the backfill/compaction/density requirements were completed/observed per the Geotech's written requirements.

C. PRE-INSTALLATION STRUCTURAL MEETING

1. At least 35 days before starting the reinforced concrete construction schedule, the Contractor must conduct a pre-installation conference at the project site to review the proposed mix designs and discuss the required methods and procedures to achieve the necessary concrete construction.
2. The Contractor must require representatives of every party who is concerned with the concrete work to attend the conference, including, but not limited to, the following:
 - a. Contractor's superintendent
 - b. Testing laboratory
 - c. Concrete/shotcrete installer
 - d. Ready-mix concrete producer
 - e. Admixture manufacturer(s) Representative (Xypex)
 - f. This Engineer
3. The Contractor must record each meeting minutes, providing typed/printed/distributed to the Architect, This Engineer, and Owner within three (3) days after the meeting.

D. QUALIFIED PERSONNEL

1. Commercial pool installer requirements:
 - a. The commercial pool installer must have less than ten (10) years of successful experience installing similar commercial-type pools.
 - 1) The commercial pool installer must supply a 100% performance, labor, and material bond.
 - 2) The commercial pool installer (or his designee) must be licensed as a commercial pool Contractor or installer and be legally authorized to perform the work outlined in the Contract Documents or must employ such a qualified, licensed installer to complete this job.
 - 3) For actual construction operations, use only thoroughly trained and experienced workers familiar with the materials, equipment, and methods specified.
2. Delegated Engineering Services to be employed by the Contractor, selected vendor/manufacturer, & Installer:
 - a. Reference to Delegated Engineering Services is equivalent to a Specialty Designated Engineer, Specialty Component Engineer, & Specialty Wet Play Engineer.
 - 1) All water recreation attractions must be designed within the limits of sound engineering practice without exception. This is a Complete Build activity.
 - b. Each Specialty Delegated Designated Engineer must be a licensed professional

engineer in the governmental locale of the project. The Contractor, as a Complete Build Activity, provides (and pays for) these professional engineers.

- 1) Specialty Component Engineer: A locally-licensed, professional engineer to provide the total specialty structural, geometric & overall design, safety plan, and product-specific signed/sealed shop-drawing designs for the following systems:
 - a) Heater ducting, dual-wall flues, and similar venting systems
 - b) HVAC and ventilation systems (independent, separate systems) for chemical and equipment room and interstitial spaces.
- 2) Specialty Wet Play Engineer: A locally-licensed, professional engineer to provide the comprehensive specialty structural-designs, geometric & overall design, wind-load certifications, lifeguard & safety plan provider incorporating operating safety, safety surfaces, grounding and bonding systems, and product-specific design for the incorporated wet play, and climbable feature structures.
3. Manufacturer: A company specializing in manufacturing the products specified with a minimum of ten years of documented experience
4. Crystalline Water-Proofing Manufacturer Qualifications: Manufacturer to be ISO 9001 registered and have no less than 10-years' experience in manufacturing the crystalline waterproofing additive add-mix within the specified concrete work.
 - a. The manufacturer must provide field service representation during the construction phase.
 - 1) Manufacturers who cannot provide the performance test data specified may not be considered and are disallowed.
 - b. Pre-construction meeting required: Before construction, the waterproofing manufacturer's representative must meet with the Contractor to discuss and coordinate activities.
 - 1) Provide the meeting minutes document to This Engineer for review and approval.
5. Shotcrete Applicator:
 - a. The selected company must supply qualified and experienced nozzlemen for this project. Each nozzleman must have a minimum of five years of documented-experience on projects like this one and be certified as per ACI 506.3R-82. Consult with manufacturers regarding concrete mix design, project conditions, and proper dosage rates of water-proof admix. Coordinate with and provide required trial mixes conducted at the Site.
 - 1) Guniting is disallowed on this project without specific written approval by This Engineer.
6. Concrete Specialty Installer:
 - a. The concrete specialty installer must be qualified in concrete repair and protection with a successful record of 5 years or more for similar projects.
 - b. Installer must maintain qualified personnel who have received documented product training by a manufacturer's representative
7. Tile and Tile Installation Materials Manufacturers:

- a. Company specializing in ceramic tiles, mosaics, pavers, trim units, and movement joints with five (5) years minimum experience.
 - b. Obtain tile components & materials from a single source with resources to provide products of consistent quality in appearance and specified physical properties such as "non-slip" and "slip-resistant."
 - c. Installation materials from manufacturers specializing in adhesives, mortars, epoxy grouts, and similar installation materials with ten (10) years minimum experience and ISO 9001 certification.
8. Tile and natural stone Installer Qualifications:
- a. Tile & stone installing company specializing in installing ceramic tiles, mosaics, pavers, trim units, thresholds, natural stone, movement joints, and epoxy grouts with five (5) years of documented experience in aquatic-type installations of similar scope, materials, and design.
 - 1) Demonstrate a prior knowledge of tile and finish movement joints
 - b. Installers of tile for wholly tiled basins must be manufacturer-certified technicians, have documented experience field-knowledge of similar aquatic projects, and install movement joints.
 - c. Installers must install water-level sensitive edges & trims (infinity edge, trims, and weirs) to be precisely level
 - 1) Exception: The maximum variance from the highest point to the lowest point must not exceed 0.125-inches [3.17 mm].
9. Pool Interior Plaster Finish Applicator / Installer: Plaster finish applicators must have a minimum of five (5) years of documented experience in the trade of pool plastering installations and the application of "Krystalkrete" or an approved equivalent quartz-aggregate-type product.
- a. The applicator/installer must be a member of the National Plaster's Council in good standing.
 - b. The installer must provide documentation/certification that the laborers performing the work on-site have been factory trained by the pool finish manufacturer.
 - c. The installer must provide a letter of reference from the pool finish manufacturer.
10. Single-layer EVA-rubber copolymer tile wet area surfacing system (Life-Floor) certified installer:
- a. Certificate of qualifications of the certified installers
 - b. Utilize a certified installer having experience with projects of similar scope and complexity.
11. Electrical Contractor / Installer: Specified electrical work to be performed by a locally-licensed electrical Contractor with a documented 5 years' experience on similar projects, including the Control Panel's installation and commissioning.
12. Wet play equipment installer: At least one 1-person who is thoroughly familiar with the materials, methods, and specific utilized equipment must be present during the construction to direct the work where required. Each installer must have a written recommendation or written certificate from the respective manufacturer.

E. MATERIALS AND REGULATIONS

1. Use of materials and equipment:
 - a. Use only approved materials and equipment.
 - b. Without exception, materials and equipment must be in “new” condition and carry a comprehensive manufacturer’s warranties beginning on Substantial Completion.
 - c. The manufacturer’s maintenance and installation instructions (with warranty documents) must accompany all equipment.
 - d. Affirm materials and equipment are not damaged or impaired by on-site storage from delivery time until the installation date.

F. ENGINEERING OBSERVATIONS

1. The Contractor must include and anticipate a minimum of five (5) Architectural / Engineering observation events, milestones, and mandatory responses in the Contractor’s scope of work, as described below.
2. This Engineer recommends that the interim observations and the Substantial Completion Observation only is conducted by The Engineer’s representative(s).
 - a. Exceptions: If This Engineer cannot observe in person, then an approved Owners’ Representative may photo-document each of the following observation events/milestones.
 - 1) Within 72-hours of the interim observation event/milestone report’s issuance, the Contractor must provide a written narrative along with the digital photos indicating the corrective action items necessitated by This Engineer’s report.
 - b. Optional Interim Observations: If specifically requested by the Owner, for an additional Professional Fee, This Engineer may be available to provide additional interim observations when multiple basins/pools/features may be on separate construction & installation schedules.
 - c. Substantial Completions Observation: The Substantial Completion Observation is especially critical to be provided only by This Engineer’s Representative(s).
3. Multiple interim observations may be required when there are numerous basins and differing installation schedules.
4. Observations requiring Martin Aquatic’s Representative or an Owners’ Representative On-Site include:

1	<u>Trip 1: Dewatering, Formwork, Rebars, Pipe/Fittings Water Pressure Testing, PVC Sch 80 pipe, Plastic Vapor Barrier, Quantity of Installed Basin Equipment, Bonding/Grounding, Potting at Lugs and Wires, Water Depths, Floor Slope, Underwater Expansion Joint(s), & Safety Fencing</u>	
	A. Name of observation at the completion of:	B. Additional Observations for the adequacy, completion/compliance per the Contract Documents, & verification of:
1	i. Rebar Grade/Spacing; ii. Additional rebars at: <ul style="list-style-type: none"> ○ protruding corners ○ drain outlets 	i. Dewatering sufficient to remove water with a standing presence and all moving & static groundwater beneath the Basin & Collector Tank;

	<ul style="list-style-type: none"> ○ light niches iii. Cut or spliced rebars have been coated with Sika Armatec 1C iv. Basin Piping Water Pressure Testing is demonstrated to be successful; v. Verify Qty of light niches, Floor & wall inlets; Drain Outlets; vi. Bonding & grounding lugs and #8 copper conductors in place – also verification of the quantity vii. Fountain junction boxes potting kit in place at each ground lug to encapsulate the connections at the lugs & wire terminations viii. Ground wires exposed to basin's water is insulated/protected at wet/immersion locations ix. Underwater light wet niche surface must not be coated, covered, or prevented from contact with the pool water. x. The sun shelf floor must be horizontal or have a uniform slope from a zero-depth entry, and its maximum depth must be between 8-inches [203 mm] to 12-inches [254 mm] below the water surface. 	<ul style="list-style-type: none"> ii. Contractor to demonstrate the formwork is level; iii. Gutters: Verify dimension width & height iv. Skimmers: Verify skimmer quantity and rebars in place to ready the skimmer bodies for their encapsulation with concrete v. Pipe & Fittings Type 2 – Dark Grey color; vi. Plastic Vapor Barrier beneath rebars; vii. Obtain a copy of Compaction & Density verified testing; viii. Excavation Depths verify; ix. Contractor to secure written approvals for compaction testing services beneath the basin excavation x. Basin floor slope constant xi. Verify Overall Dimensions; xii. Underwater expansion joint assemblies in place; Verify Quantity of joints – in the beam, coping, floors, & walls xiii. Discuss waterproofing admix; xiv. Temporary Safety Fencing xv. Sun shelf is located at locations being no more than 4-Feet of water depth xvi. Sun shelf areas must be a minimum of 20-inches [508 mm] wide and provide a minimum of 10-SF [0.93 SM] of horizontal surface adjoining on the edge of the pool over a distance of not less than 3-feet [914 mm]. xvii. River-ride basin maximum water depth is no more than 3-feet unless justified & approved
2	<u>Trip #2:</u> Water Pressure Testing, PVC Sch 80 pipe, Collector Tank, Backfill & Compaction Testing, & Link Seals	
	C. Name of observation at the completion of:	D. Additional Observations for the adequacy, completion/compliance per the Contract Documents, & verification of:
2	<ul style="list-style-type: none"> i. Water-pressure-gauges with readings signify the ongoing water-pressure successful testing of all under-deck, underground, and underwater piping & light conduits. 	<ul style="list-style-type: none"> i. Collector tank: Location and elevation as related to basin water level ii. Dewatering sufficient to remove water with a standing presence and all moving & static groundwater beneath the Collector Tank;

	<ul style="list-style-type: none"> ii. Piping interface between the basin and the piping within the equipment room space must be observed & photo-recorded before backfilling and covering of under-deck and underground piping. iii. Presence of Link-Seals at wall penetrations iv. Additional and follow-up observations of water-pressure testing on the Equipment Room piping systems. v. Review each light niche's waterproofing, each wall inlets, each floor inlet, each state pipe, & around each floor drain outlet. vi. Review all compaction test results as provided by the contractor. 	<ul style="list-style-type: none"> iii. Collector tanks & equipment vaults are backfilled with tested, confirmed, compacted soils. iv. Contractor to secure the written approvals for the compaction service required Engineering Testing Services beneath the collector tanks & around piping ditches v. Earthen backfill around the pool perimeter is backfilled, compacted, & tested. Contractor to secure required Engineering Testing Services' written approvals for compaction around the entire pool perimeter. vi. Refer to these Specifications concerning the PIPE & FITTINGS MATERIAL TYPES' materials. As an example, visual observation noting that Type 2 (dark grey) piping & fittings are located: <ul style="list-style-type: none"> ○ beneath the pool basin structure ○ when the interconnecting pipe size (between basin and pool equipment room) exceeds 6-inch [150 mm], ○ piping within the equipment room
3	<u>Trip #3:</u> Tile Install with Epoxy Grout, Pipe Supports & Braces, & Deck Area Equipment	
	E. Name of observation at the completion of:	F. Additional Observations for the adequacy, completion/compliance per the Contract Documents, & verification of:
3	<ul style="list-style-type: none"> i. Basin observation with most finish components (must be after the installation of the below items), but before installation of the interior surface finish material: <ul style="list-style-type: none"> ○ Movement, isolation, & expansion joints, ○ coping units with grouting in-place, ○ wall-tile with grouting in-place, ○ step-tile with grouting in place, 	<ul style="list-style-type: none"> i. Pipe supports and hangers in the equipment room prevent pipes' movement and support pipes to prevent excessive pressure on pumps & other equipment. ii. Verify that all hangers and supports are tight – to prevent movement. iii. Match the installed equipment within the room to comply with the Contract Documents. iv. Verify the locations of the following deck area equipment is per the Contract Documents: <ul style="list-style-type: none"> ○ deck shower (water parks must have the deck shower(s) located near the entrance (queue line) to a water recreation attraction.) ○ all hose bibbs are provided with a vacuum breaker

	<ul style="list-style-type: none"> ○ PermaKote is installed over the water-blasted basin interior surface. ii. Pool Rules sign installed (with minimum 1-inch tall letters) pool or at the entrance to a water park: <ul style="list-style-type: none"> ○ BATHING LOAD: ____ (Pool bathing load is 1 per each 5 GPM) ○ NO FOOD OR BEVERAGES ○ NO GLASS OR ANIMALS ○ SHOWER BEFORE ENTERING ○ DO NOT SWALLOW POOL WATER ○ NO NIGHT SWIMMING (unless the Owner has provided a deck & pool illumination plan certifying 3 F.C. of overhead illumination in all water locations). ○ For Night Swimming (pool areas less than 3-feet deep must have 6 F.C. of overhead illumination - Signed/sealed engineering documents are required) ○ POOL BASIN MAXIMUM WATER DEPTH: ____ FEET ○ POOL OPERATING HOURS: SUNRISE TO SUNSET ○ NO DIVING (4-inch high letters) ○ MAXIMUM WATER TEMPERATURE: 104-DEG. F (40-DEG C.) (when a heater is installed) iii. Sun Shelf Rules sign installed: 	<ul style="list-style-type: none"> v. The wall tiles, gutter lip tiles, step tiles, bench tiles, and sun shelf edge tiles are grouted with epoxy grout. vi. Depth Markers in Pool Basin and at Deck Edge (with non-slip/slip-resistant surface); Spas larger than 200 Sq. Ft has depth markers the same as a pool. vii. International No Diving Signage at the deck edge (with a non-slip surface) viii. Pool restroom directional signage installed ix. Restrooms separate for each sex. <ul style="list-style-type: none"> ○ a hose bibb with a vacuum breaker is provided in or within 25-feet of each restroom ○ the outside-opening-doors are labeled "Men" & "Women" or "Family." ○ Each restroom is equipped with a diaper changing station x. Restroom fixture sets comply with the FBC and the Engineering Drawings. There are no foot baths, carpet, or duckboards on restroom floors. xi. Restroom wall/floor junctions are coved xii. Restrooms are completed and are within 200-foot walking distance to the pool basin or exit to a water attraction xiii. Safety Equipment mounted (2 sets when pool length exceeds 50-ft) to include: <ul style="list-style-type: none"> ○ shepherd's hook with a one-piece pole (minimum 16-feet long) ○ lifesaving rings (min. 18-inches diameter) with sufficient ropes attached to reach all parts of the pool from the deck, mounted along each of the longer sides of the pool. xiv. Permanent Fence 48-inch high and Self-Closing, Lockable Gate is Completed (4-inch sphere rule applies) <ul style="list-style-type: none"> ○ For Equipment Yards ○ For Pools & IWF, etc. ○ Separate fence at IWF's, Wading Pool, & Water Activity Pool (refer to the Landscape Arch's Drawings) located within 50-feet of a pool ○ For the stair/ladder entrance to each slide.
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	<ul style="list-style-type: none"> ○ WARNING: DROPOFF AT SUN SHELF EDGE IS "x" FEET DEEP (in 4-inch letters) ○ DO NOT PLACE FURNITURE IN POOL <p>iv. Water play structures with overhead clearances of less than 4' are blocked preclude children from becoming entrapped</p> <p>v. All rules signs must have 3-Foot Candles of illumination when the pool/spa is authorized for night swimming.</p> <p>vi. IWF's with night operation proposed must have 6 F.C. (60 lux) of overhead lighting must be provided on the wet deck and the Interactive Water Feature area. Signed/sealed illumination engineering documents are required.</p>	<p>xv. Final Electrical Power is "ON"</p> <p>xvi. Spa Rules sign installed (with minimum 1-inch tall letters):</p> <ul style="list-style-type: none"> ○ (in addition to the pool rules) ○ SPA BATHING LOAD: _____ ○ (1 person per every 10 square feet) ○ MAXIMUM WATER TEMPERATURE: 104-DEG. F (40-DEG C.) ○ CHILDREN UNDER 12 MUST HAVE ADULT SUPERVISION ○ PREGNANT WOMEN, SMALL CHILDREN, PEOPLE WITH HEALTH PROBLEMS AND PEOPLE USING ALCOHOL, NARCOTICS, OR OTHER DRUGS THAT MAY CAUSE DROWSINESS SHOULD NOT USE SPA POOLS WITHOUT FIRST CONSULTING A DOCTOR. ○ MAXIMUM USE: 15 MINUTES <p>xvii. Additional signage rules for IWF's and Water Activity Pool include:</p> <ul style="list-style-type: none"> ○ DO NOT SWALLOW THE FOUNTAIN WATER; IT IS RECIRCULATED. ○ DO NOT USE FOUNTAIN IF YOU ARE ILL WITH DIARRHEA.
4	Trip # 4: Electrical Engineer Review of all Electrical Installation & Equipment, Potting in Junction Boxes, Eq Room Bonding & Grounding, Panel Enclosures Front Clearances, Deck Area Electrical Equipment, & Obtain Contractor's certification of Bonding/Grounding	
	G. Name of observation after:	H. Additional Observations for the adequacy, completion per the Contract Documents, & verification of:
	<p>i. Electrical Engineer to review all electrical equipment, control panel, clearances, enclosure type, UL Listings, adequacy, and compliance with the Contract Documents</p> <p>ii. Perform a pre-commissioning review</p>	<p>i. Electrical review of all basin and deck area electrical installation</p> <p>ii. Bonding/grounding wire is installed on the interior (inside) of each underwater light niche</p> <p>iii. Bonding & grounding wires connected to the significant metallic equipment located in the equipment room.</p> <p>iv. Review the clearance spaces in front of each panel enclosure & VFD</p> <p>v. The contractors must demonstrate the placement of:</p>

	<ul style="list-style-type: none"> iii. Collect & secure the Contractor's written certification or demonstration of the "ringing" resulting from the successful completion of the bonding & grounding testing iv. Review Chemical Systems, UV, and VFD interface with Control Panel v. Review Chemical controller, flow sensors, auto-Fill, wind velocity controls, underwater light controls 	<ul style="list-style-type: none"> ○ Re-enterable potting materials in all underwater junction boxes. ○ Wago Connectors in all Junction boxes (if not visible, then a letter from the contractor is required) vi. Verify the locations of the following deck area equipment is per the Contract Documents: <ul style="list-style-type: none"> ○ electrical receptacle for potable vacuum pump connections ○ underwater light transformers/power supplies vii. When pumps are de-activated, do the chemical feeders & UV Systems turn "off?" viii. Verify the presence of the UL-Listed identification label(s) on each equipment component.
5	<p>Trip # 5: Substantial Completion & Owners' Acceptance - This is a critical observation and is strongly recommended to be performed only by This Engineer's Representative(s). Commissioning activities.</p>	
	I. Name of observation at the completion of:	J. Additional Observations for the adequacy, completion/compliance per the Contract Documents, & verification of:
	<ul style="list-style-type: none"> i. Contractor's completion of all commissioning activities as noted in these Technical Specifications ii. Verify that the contractor has provided: <ul style="list-style-type: none"> ○ All warranties ○ Record-set drawings for "As-Built." ○ Copies of Final Governmental Permits indicating successful completion. ○ All waivers of liens 	<ul style="list-style-type: none"> i. Verify that the Contractor has provided: <ul style="list-style-type: none"> ○ all training events, including video of all instructions. ○ Pipe tags, color bans, labeling, wall-mounted piping diagram charts ○ Manufacturer written certifications of proper installation in compliance with their instructions ii. Adequate access must be provided to the sump or collector tank via stairs, or a ladder must be provided as needed to ensure safe entry into the tank. iii. The Site, Basins, Wet-Deck are completed, and no construction debris is visible.
6	<p>Trip # 6: Nominal 1-year after Substantial Completion – (Optional: Requires Owner's Approval -- This is an optional observation (for additional professional fees & reimbursable travel costs), possibly by Martin Aquatic only if approved by the Client or Owner).</p>	

	Name of observation at the completion of:	Additional Observations for the adequacy, completion per the Contract Documents, & verification of:
	i. No later than 10-months from the date of Substantial Completion, a Martin Aquatic representative will conduct a thorough review of the project to determine if any products, equipment items, or materials have failed	i. A complete listing of deficiencies will be provided to the Contractor for correction and replacement ii. The Contractor will be required to make noted corrections within 30-days
7	Trip # 7: Nominal 2-years after Substantial Completion - (Optional: Requires Owner's Request)	
	Name of observation at the completion of:	Additional Observations for the adequacy, completion per the Contract Documents, & verification of:
	i. No later than 22-months from the date of Substantial Completion, a Martin Aquatic representative will conduct a thorough review of the project to determine if any products, equipment items, or materials have failed	i. A complete listing of deficiencies will be provided to the Contractor for correction and replacement ii. The Contractor will be required to make noted corrections within 30-days

5. Provide 72-hour notice of these observations by informing the Architect and This Engineer.

6. Photo-Documentation events required:

- a. Underwater light and pump junction boxes after the potting Re-Enterable Compound are installed (perform the photo documentation without the junction box's cover being installed), revealing the installed potting compound's adequacy.

- 1) Submit to This Engineer within 2 days of the completed provision of the Re-Enterable Potting Compound.

7. Coordinate additional governmental inspections with the local building department and other regulatory agencies as may be specified.

G. TESTING SERVICES

1. General for Site Compaction & Density Conditions:

- a. Provide written reports from licensed testing engineer indicating successful compliance with specified requirements to include:

- 1) Compaction Testing Services at the following locations:
 - a) Beneath basin and adjacent decking
 - b) Beneath the collector / surge / reservoir tank(s)
 - c) Beneath below-grade rooms / vaults
 - d) Within pipe trenches, before piping installation
 - e) Excavations beneath previously-compacted locations (such as basin structures and placed-decks) must require a professional recommendation from the Geotechnical Consultant about the proper compaction method or methods to fill voids between soils, potential sinkholes, and the underside of a structure or deck.
2. General for Dewatering Conditions
 - a. Provide written reports from licensed testing engineer indicating successful compliance with specified dewatering requirements to include:
 - 1) Dewatering of all specified excavation areas to include the following locations:
 - a) Beneath basin excavation
 - b) Beneath collector, surge, & reservoir tank(s)
 - c) Beneath piping trenches with visible groundwater
3. General for Shotcrete / Concrete Materials
 - a. The following compression/break cylinder tests must be made and recorded:
 - 1) 7 days
 - 2) 14 days
 - 3) 28 days
 - 4) 56 days
 - 5) The last cylinder (5th) must be left available for 120 days
 - b. Before the start of work, the testing firm must verify mix proportions, gradation, and aggregate quality. Written certification of aggregates' quality must be provided to the Architect and This Engineer.
 - c. Identification number or name of mix to verify agreement with compression test reports.
 - d. Concrete/shotcrete must be successfully tested before the application of any surface finish work.
 - 1) Testing results must be recorded and submitted to the Architect and Contractor for approval before the basin installation work.

H. SUBSTANTIAL COMPLETION

1. AIA Form G704-2017 Certificate of Substantial Completion is the designated form to acknowledge Substantial Completion.

- a. The use or installation of unauthorized equipment/materials, deviant/unauthorized execution or installation, unauthorized labor activities, unauthorized substitutions (those not authorized in writing by Martin Aquatic), unauthorized alternates or inadequate executions, sub-standard workmanship (as judged by Martin Aquatic), omissions, deviations, implementation of unauthorized details, and unauthorized dimensions, must relieve Martin Aquatic from all liability and responsibility for the operating permits' non-issuance, performance, bathers, operators, & patrons' safety, non-issuance of the AIA Form G704-2017 Certificate of Substantial Completion, or warranty of the project described herein or on the Drawings.
2. Any work that remains to be completed after the project has reached Substantial Completion is generally referred to as punch list work, and its full-completion usually constitutes Final Completion.

1.10 CONSTRUCTION FACILITIES

A. TEMPORARY ELECTRICITY AND WATER

1. Provide and meter the water used in the leak testing.
2. Provide and meter electrical power during the construction period.

B. SITE WORK, TRENCHING, AND PLENUMS

1. Exact locations of below-grade equipment, including piping and electrical centers, must be verified before excavation and coordinated with the owner's representative and the Architect.
2. Core-Drilling or Concrete Penetrations:
 - a. Obtain specific written approval from the Architect before core-drilling or penetrating concrete floors or walls after the concrete has been placed.
 - b. No penetrations or anchors through or into building walls, floors, or ceilings must be made without prior written approval from the Project's Structural Engineer of Record.
3. Piping between the Equipment Room, basin, and perimeter basin piping must be located only in main subterranean trenches or designated passageways within "on-structure" projects.
 - a. If applicable, trenches must be excavated, protected, backfilled, and compacted per codes, regulations, and the Contract Documents without exception.
4. No rated building partitions must be penetrated unless expressly approved in writing by the Project's Architect.
5. No PVC or similar petrochemical piping may be installed into plenums.

1.11 MATERIAL AND EQUIPMENT - GENERAL REQUIREMENTS

A. PRODUCTS

1. Except as explicitly noted in the Contract Documents, a single manufacturer's products for each type category of material or equipment must be utilized throughout.

B. EQUIPMENT DUTY RATING

1. Equipment and materials must be capable of both continuous and intermittent duty rating and operation.
2. Pump motors controlled via VFD's must be VFD Duty rated.

C. CONDITION OF MATERIALS AND EQUIPMENT

1. Materials and equipment must be new, undamaged, and protected, and secured throughout the construction period. The equipment and materials remain in a new condition at the time of Substantial Completion. Deliver and store equipment, materials, and product components with labels intact and legible.
 - a. Immediately inspect all delivered equipment, materials, and products to confirm they are undamaged and in excellent condition. Report damages and unacceptable conditions on the Contractors' daily report.
 - b. /with identification labels intact.
2. Store expansion joints & water stops indoors or under appropriate tarps to protect from premature exposure to oil, sunlight, moisture, and water.
3. Store and dispose of solvent-based materials such as construction adhesive and materials used with solvent-based materials, following local authorities' requirements.
 - a. Store all materials in such a manner to protect from exposure (the sun, rain, & moisture) to potentially-harmful environmental conditions and at a minimum temperature of 20 degrees F (-7 degrees C) and a maximum temperature of 100 degrees F (38 degrees C).

D. PERFORMANCE CERTIFICATION REQUIRED:

1. The water entering the pool must be pristine, bright, free from suspended matter visible to the unaided eye. The basin's water must be sanitary-rated as potable to the satisfaction of governmental authorities and This Engineer.
2. The equipment suppliers and manufacturers must certify/guarantee that their equipment to be furnished is:
 - a. the correct capacity
 - b. the various components/parts are designed to operate correctly and in conjunction with each other
 - c. to perform the prescribed functions correctly & precisely

1.12 WARRANTIES & SPECIAL PROJECT REQUIREMENTS

A. TWO-YEAR WARRANTY – EQUIPMENT AND MATERIALS INSTALLATION:

1. Provide a minimum two (2) year warranty covering pool workmanship, materials, and equipment from the date of Substantial Completion of the work (or longer if specified in the General Conditions and herein).
2. It is the responsibility of the Contractor to coordinate warranty requirements with any related sections or adjacent Work. Notify the Architect and This Engineer immediately of any potential lapses or limitations in warranty coverage.
3. Standard manufacturer's warranties must apply to equipment, materials, and products provided by the Contractor.

B. MANUFACTURER'S WARRANTY:

1. General:
 - a. Two-year manufacturer's warranty minimum for defects in materials and equipment (or more extended if so specified elsewhere by the specific manufacturer) from Substantial Completion date.
 - 1) Five-year warranty on quartz aggregate plaster finishes
 - b. The Owner must be named on manufacturers' warranties.
 - c. Replace equipment that fails or shows excessive wear.
 - d. Additional warranties must be as specified in the Architect's Division 1 - "General Conditions."
 - e. When equipment items are provided with a more extended warranty than the minimum warranty period, in that case, those warranties also must be transferred to the Owner as part of the Project Close-Out Documents.
2. These manufacturers must provide specific additional warranties:
 - a. Accessible Lift Units: Five-year warranty for the lift unit and anchor
 - b. ChlorKing® power supply must be warranted as follows:
 - 1) The manufacturer warrants:
 - a) The electrical components, pumps, and cell containment tank of the ChlorKing® systems to be free of defects for one year from the date of installation.
 - b) Electrode plates of the ChlorKing® system for one year, and then prorated for one year after. (See actual warranty statement for details)
 - c) assembly and quality of components of the ChlorKing® system to be free of defects for three years.
 - c. Enduro Turbo-Clean XL Robotic Automatic Pool Vacuum Cleaner System:
 - 1) Stainless steel casing: Seven-year warranty
 - 2) Overall device: Two-year warranty
 - d. EVA-rubber Copolymer Wet Area Surfacing System (Life-Floor)
 - 1) Manufacturer warrants all 7/8-inch and 3/8-inch-thick EVA-rubber Copolymer Wet Area Surfacing System for a term of Five-years from the date of delivery.
 - 2) The manufacturer must warrant all 3/16-inch-thick EVA-rubber Copolymer Wet Area Surfacing System tiles for a term of Three-years from the date of delivery.
 - 3) The manufacturer must warrant all tiles for a term of Two-years from the date of delivery.
 - e. Grating by Daldorado: Ten-year warranty
 - f. Herborner Pumps:
 - 1) The manufacturer's warranty period must be for five years from the date of shipment.
 - 2) Warranty must cover against defective material and faulty workmanship from the manufacturer.
 - 3) Bearings are excluded and have a 12 months warranty
 - 4) If the pump is not equipped with the option Seal Guard System, the mechanical seal is excluded and has a 12 months warranty period.

g. Marlow, Armstrong, Hayward, & Pentair Pumps:

- 1) Manufacturer's standard pump warranty. Warranty on mechanical seals covering 100% of parts and labor costs extending over the same period as the provided pump warranty.
- 2) Pump failure of any pump component directly attributable to materials or workmanship within Two-years after shipment must be repaired or replaced FREE of charge by the pump manufacturer.
- 3) Motor failure of any motor component directly attributable to materials or workmanship within Three-years after shipment must be repaired or replaced FREE of charge by the pump manufacturer.

h. Pulsar:

- 1) Manufacturer warrants parts (excluding electrical components) of the Sanitization System to be free of defects in workmanship and material for 2 years from the date of installation.

i. Rails (& Ladders): Warranty duration must be a minimum Three-years from the date of installation & cover any failure in the material defect.

C. MAINTENANCE, OPERATION, & SUPPLY PERIOD

1. Contractor-provided chemical-supply, cleaning, and maintenance responsibilities include:
 - a. Comprehensive care, the operation of equipment, routine maintenance, the supply of chemicals, and typical expendables keeping the system operating within specified parameters for the initial first 30-days.
 - 1) The Owner must provide electrical power and replenishment of potable water during this initial Contractor-responsibility period
 - b. Refer to the Chemical Feeder sections for additional chemical supplies to be provided to the Owner by the Contractor.

PART 2 - PRODUCTS

2.01 BASIC POOL BASIN CONSTRUCTION MATERIALS

A. GENERAL

1. It is the design intent of these technical specifications, Drawings, and Contract Documents for the Contractor (and his selected Installers) to provide equipment, labor, materials, & supervision as required (without exception) for the construction and installation of the pool(s) & related assemblies at this project site.
2. Basin installation activities by the Contractor include:
 - a. layout, forming, excavation, dewatering, piers & piles, compaction, reinforcing steel, basin structural concrete with waterproofing.
3. Upon the successful completion of the basin structure, the contractor must provide:
 - a. backfill & compaction, piping & valving systems, basin and deck equipment, textured finishes, collector, reservoir, surge tanks, tank anchoring, and tank drainage (for below-grade tanks).

4. The Contractor must also provide the filtration systems, pumping systems, chemical systems, air compressors, miscellaneous equipment systems as noted herein and in the Drawings, Contract Documents, electrical, and other components, equipment, labor, materials, & supervision needed, although not explicitly listed.
5. Additionally, included also by the Contractor must be all required components, equipment, labor, materials, & supervision for start-up, commissioning, chemical balancing of basin water, warranty, instruction, maintenance during the initial operating period's operation, programming, and similar products & services.
6. Application, employment, and use of components, equipment, labor, materials, & supervision must be per the manufacturer's instructions & recommendations, this Engineer's requirements, and the Contract Documents. Written certifications from each manufacturer must certify that the Contractor provided proper equipment, installation, and executed the installation to their satisfaction & standards.
 - a. In the event of a conflict, notify This Engineer in writing requesting a written clarification.

B. GEOTEXTILE NONWOVEN FILTER FABRIC

1. Filter fabric must be nonwoven, needle-punched, geotextile made of 100% polypropylene staple filaments.
2. The polypropylene material must resist ultraviolet and biological deterioration, rotting, naturally encountered bases, and acids.
3. The polypropylene must be stable within a pH range of 2 to 13 and satisfy the requirements as outlined in AASHTO M288-06 for Class 3 applications and meet the following M.A.R.V. values:

Property	Test Method	Imperial	Metric
Weight	ASTM D-5261	4.5 oz./square yd.	142 g.sm
Tensile Strength	ASTM D-4632	120 lbs.	533 N
Elongation	ASTM D-4632	50%	50%
Mullen Burst	ASTM D-3786	225 psi	1,551 kPa
Puncture Strength	ASTM D-4833	65 lbs.	1,513 N
CBR Puncture	ASTM D-6241	340 lbs.	1,513 N
Trapezoidal Tear	ASTM D-4533	50 lbs.	222 N
Apparent Opening Size	ASTM D-4571	70 US Sieve	0.212 mm
Permittivity	ASTM D-4491	1.70 Sec-1	1.70 Sec-1
Water Flow Rate	ASTM D-4491	120 gpm/sf	4,885 l/min/sm
UV Resistance	ASTM D-4355	70%	70%

5. The Basis of Design: Model US 120NW as manufactured by US Fabrics, Inc., 3904 Virginia Avenue, Cincinnati, OH 45227; 800.518.2290; info@usfabrics.com; www.usfabrics.com

C. DRAINAGE MAT

1. General

- a. Drainage Mat composites must incorporate high flow dimpled core as well as high crush resistant geonet constructions.
- b. The Drainage Mat composite performs a multi-faceted role by providing protection for (Sika) RoofPro and Sikalastic®-320 NS/SL membranes and a means of collecting and conveying excess water in plaza decks, split slabs, planters, roof gardens, and other roofing and waterproofing applications.

2. The Drainage Mat must consist of an impermeable high flow dimpled polypropylene drainage core heat-bonded to a layer of non-woven and woven polypropylene fabric on the top side and a polyethylene membrane protection film on the bottom side.

- a. The filter fabric retains soil or sand particles and freshly placed concrete or grout, allowing filtered water to pass into the drainage core.
- b. Use the nonwoven filter fabric with soil, sand, or stone ballast; use the woven filter fabric with freshly placed concrete or grout.

3. Manufacturer Authorized Use of Material

- a. Plaza Decks
- b. Split slabs
- c. Ballasted roofs
- d. Foundation Walls

4. Materials' Characteristics/Advantages

- a. Variable flow and compressive strength configuration
- b. High crush-resistant configurations
- c. Pre-assembled filtration and membrane protection layers
- d. Conformable to irregular surfaces
- e. Mildew and rot-resistant

5. Product Information

a. Construction:

	Drainage Mat
i. CBR Puncture (ASTM D-6241)	i. 850 Lbs. [3.78 kN]
ii. AOS (EOS)	ii. 40 US Sieve [0.42 mm]

b. Dimensions / Weight / Thickness:

	Drainage Mat
i. Width x Length	i. 4' x 50' [1.2 x 15.2 m]
ii. Weight (per unit)	ii. 50 Lbs.
iii. Thickness	iii. 0.40-Inches [10.16 mm]

c. Technical Information

	Drainage Mat
i. Compressive Strength	i. 21,000 PSF [1,447 Bar]
ii. Opening Size	ii. 40 US Sieve
iii. Flow-Through Core: Water Flow Capacity	iii. 23 gal/min/ft
iv. Flow-Through Fabric: Water Flow Capacity	iv. 60 gal/min/ft

6. Basis of Design: Sika Drainage Mat Model 720 by Sika Corp., 201 Polito Avenue, Lyndhurst, NJ 07071; Phone: +1-800-933-7452; www.usa.sika.com

D. VAPOR BARRIERS

1. 10-mil extruded virgin polyolefin resins) single sheet) with the following minimum properties:
 - a. Virgin polyolefin resins
 - b. The described 10-mil vapor barrier/retarder membrane must comply and meet the minimum requirements of ASTM E1745 Class A, B, and C and the following ASTM's:

Property	ASTM	Value
Water Vapor Permeance	F1249 (perms)	0.018
Puncture Resistance	1709 (grams)	3000
Tensile Strength	D882 (lb. f/in ³)	58
Life Expectancy	E154 (years)	Indefinite
Roll Dimensions	Feet [M] square Feet [square M]	14 x 200 [4.26 x 60.9] 2800 [260.13]
Roll Weight	lb. [kilograms]	134.6 [61.05]
Thickness (nominal)		10 mil's

2. The Basis of Design: Vapor Barrier Model "Vapor Barrier 10 mil" as manufactured by Americover, 2067 Wineridge Place, Ste F, Escondido, CA 92029, 800-747-6095, www.americover.com.

E. CRUSHED ROCK / STONE

1. Stone description:
 - a. Provide a 4-inches [100 mm] minimum layer of 0.75-inch [20 mm] non-porous rock/stone beneath the basin floor. This material must be equal to a #57 crushed stone.
 - b. Separate the crushed stone and the adjacent earthen soils with a geotextile nonwoven filter fabric.

F. STEEL REINFORCEMENT

1. Steel reinforcing bars must be of the sizes and configuration shown in the applicable sections of the Drawings.
 - a. Bars and Associated Materials: Provide Grade 60 [Grade 420 Metric], new, and free of rust and scale.
2. Bars placed into the pool beam with less than 2.5-inches of waterproof concrete cover must be #2 hot-dip galvanized, pencil-rod, deformed bars.
 - a. The Basis of Design: DUR-O-WAL DA8706 or pre-approved equal
3. Bars that have been cut or spliced must be coated with a bonding primer and a reinforcing corrosion protection coating.
 - a. Basis of Design: Sika Armatec 1C provide as directed by the manufacturer; Sika Corporation, 201 Polito Avenue, Lyndhurst, NJ 07071, Phone: +1-800-933-7452
www.usa.sika.com
4. Where seawater may encounter the basin structure, steel must be coated with a rust inhibitor (or epoxy) coating (factory-applied after cutting). Do not cut any reinforcing bars in the field when provided with a protective coating.

G. JOINTS

1. Slip dowel system for expansion joint alignment
 - a. Provide Sika Greenstreak Speed Load System for expansion joints, to accept 1-inch [25 mm] diameter x 18-inch-long [457 mm] slip/smooth dowels @ 24-inch [609 mm] on-center.
 - 1) The unit is comprised of a one-piece polypropylene plastic sleeve with the base.
 - 2) Provision for assuring proper field positioning and alignment of slip dowels at concrete expansion joints.
 - 3) Provisions for allowing free shrinkage and expansion of concrete surfaces adjacent to expansion joints while providing proper load transfer and preventing differential vertical movement.
2. Keyways insert for construction-joint alignment
 - a. Sika Greenstreak 3.50-inches [89 mm] plastic keyway inserts (Catalog No. 521).
 - 1) Provision for assuring concrete surfaces adjacent to construction joints provide load transfer while preventing differential vertical movement.
3. Movement joints for finishes:
 - a. Mandatory movement joints are required in horizontal and vertical planes for the various installations of coping, natural stone, racing lanes, wall & gutter tiles, and similar finishes.
 - b. Flexible sealants for movement joints must be a high performance, one component, neutral cure, 100% silicone sealant designed for tiles and stone applications, and comply with the following:
 - 1) Must be manufacturer-certified for use in:
 - a) interior and exterior locations
 - b) swimming pool & wet area applications
 - c) expansion joints in residential & commercial applications

2) Physical properties:

- a) Durometer Hardness- Shore A: 27
- b) Tensile Strength: 280 psi [1.9 MPa]
- c) Dynamic Joint Movement: +/- 25%
- d) Weatherability (10,000 hours QUV
Weatherometer: No Change

3) Available in a wide variety of colors

c. The Basis of Design:

- 1) Model 4.16 Schluter®-DILEX-EDP; Schluter Systems L.P., 194 Pleasant Ridge Road, Plattsburgh, NY 12901-5841; +1.800.472.4588; www.schluter.com
- 2) LATASIL sealant; Laticrete International, Inc., One Laticrete Park North, Bethany, CT 06524; 800.243.4788; www.laticrete.com

H. POLYPROPYLENE EXPANSION BOARD

1. The manufacturer must certify the product as having the following properties:

- a. Excellent compression and recovery properties
- b. Does not rot or deteriorate
- c. Sturdy and durable; must not break with normal handling
- d. Lightweight, easy to handle
- e. Resistant to a wide variety of chemicals and solvents
- f. Can be cut with conventional tools
- g. Must not split; can be fastened to stakes with screws or ring shank nails
- h. Excellent for use with Sika Greenstreak's Speed Dowel® joint system

2. Dis-allowed products:

- a. Asphalt
- b. Impregnated fiberboard
- c. Pine or redwood (or similar wood products)

3. Physical Properties

Property	Test Method	Typical Value
Flat Crush-Resistance	TAPPL-T 825	95-Psi
Resistance to Handling	ASTM D1725	Complies

4. The Basis of Design: ½ inch and ¾ inch Polypropylene Expansion Board; Greenstreak, 3400 Tree Court Industrial Blvd., St. Louis, MO 63122; 800.793.7832; www.usa.sika.com

I. EXPANSION JOINT FILLER

1. General:

a. Provide one of the following:

- 1) A preformed, closed-cell, low-density PE (polyethylene) foam joint seal filler.
- 2) An Asphalt Expansion Joint Filler composed of asphalts & mineral fillers formed under heat and pressure between two asphalt-saturated liners.

2. Required features include:

- a. Non-absorbing and protects against the infiltration of fines and water
- b. Self-sealing (no additional joint sealant required)
- c. Dynamic movement range of -50%, +25%, & +- 50% shear
- d. Allowed for use in below-grade applications
- e. No anchoring system required
- f. Allowed for use in pool basin concrete structures

3. Basis of Design:

- a. Metazeal-s by Chase Construction Products; 295 University Ave., Westwood, MA 02090, USA; 800.323.4182; www.chasecorp.com
- b. Asphalt Expansion Joint Filler #321 by W.R. Meadows, Inc., P.O. Box 338, Hampshire, IL 60140; 800.342.5976; www.wrmeadows.com

J. BACKER ROD & TAPE

- 1. General: ¾" closed cell polyethylene-based backer rod used to partially fill deep cracks and joints before applying sealant. Size may vary – refer to the Drawings.
 - a. Sika polyethylene-based bond breaker tape is pre-approved for joints too shallow to accommodate the backer rod
- 2. The manufacturer must certify the following:
 - a. Easy to apply
 - b. Highly flexible and compressible
 - c. Does not absorb water
 - d. Excellent temperature resistance
 - e. Prevents 3-sided adhesion
 - f. Controls sealant depth

3. Data:

Density	2.0 lbs./cu. ft.
Tensile strength	50 PSI
Compression deflection	5 PSI @ 25%
Water absorption	0.03 gm/cc
Temperature range	-90°F to 210°F

- 4. The Basis of Design: ¾ inch Sika Greenstreak Pro Select closed cell backer rod, Sika Greenstreak, 3400 Tree Court Industrial Blvd., St. Louis, MO 63122; 800.793.7832; www.usa.sika.com

K. ADMIXTURES

- 1. Crystalline waterproofing additive
 - a. System Description: Concrete waterproofing system must be of the crystalline type, defined by the ACI 212.3R – 10 Report on Chemical Admixtures for Concrete as a "PRAH" type hydrophilic admixture.
 - 1) It must react such that it chemically controls and permanently fixes a non-soluble crystalline structure throughout the concrete's capillary voids.

- 2) The system must cause the concrete to become sealed against liquids' penetration from any direction and protect the concrete from deterioration due to harsh environmental conditions.
 - 3) Xypex Admix must be added/blended to the concrete mix at the time of batching.
 - a) For enhanced chemical protection or to meet specific project requirements, or where the concrete mix design contains higher than 20% fly ash content or includes a Portland cement/slag cement blend, capacity the contractor or his consultant must coordinate with the manufacturer or its authorized representative to determine appropriate dosage rate and product type.
 - b) The ready-mix supplier must coordinate with Xypex to certify the proper type and dosage of Xypex must be provided based on, but not limited to, the specific products used in the mix design and the conditions at the job site. A written confirmation stating that this coordination has taken place must be provided in the same submittal package as the concrete mix designs.
 - b. The Basis of Design: Xypex Chemical Corporation, 13731 Mayfield Place, Richmond, B.C., Canada V6V 2G9, Tel: 800 961.4477 or 604 273.5265 Fax: 604 270.0451 E-mail: info@xypex.com Website: www.xypex.com
 - 1) Xypex Admix Type C-500-NF or C-1000-NF (as recommended by the manufacturer for the specific mix(es) being used) by Xypex crystalline waterproofing materials as follows:
 - a) Utilize this additive formula unless noted otherwise in the drawings or these specifications.
 - b) Dosage Rate (for this Admix only): 1.25% by weight of Portland cement content
 - 2) Alternate, approved formulation: Xypex type C-500 and C-1000.
 - a) Dosage Rate (for this Admix only): 2.50% by weight of Portland cement content
 - c. Substitutions: Not permitted
 - d. Source Quality: Obtain proprietary crystalline waterproofing products from a single manufacturer.
 - e. Setting Time and Strength:
 - 1) Some retardation of the set may occur when using Xypex Admix products. The retardation amount must depend upon the concrete mix design, the Admix product used, the Admix dosage rate, the concrete's temperature, and climatic conditions.
 - 2) Concrete containing a Xypex Admix product may develop higher ultimate strengths than untreated concrete, with no such admixture.
2. Admixtures, General:
- a. Use air-entraining admixture in exterior concrete, unless otherwise indicated. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the following limits:
 - 1) Concrete structures and slabs exposed to freezing and thawing or subjected to hydraulic pressure:

- a) 3 to 15 percent for maximum 2-inches aggregate.
 - b) 4-1/2 % to 6-1/2 % for maximum 1-inch aggregate.
 - c) 5 to 7 percent for maximum 3/4-inch aggregate.
 - d) 6 to 8 percent for maximum 1/2-inch aggregate.
 - e) Other Exterior Concrete: 2 to 4 percent
- b. The use of admixtures for water-reducing and set control must be permitted only with the engineer's prior approval for each condition. Before considering any mix design changes, the proposed change must be in strict compliance with the manufacturer's directions without exception.
 - c. Design mix submittals must include these admixtures and indicate which types of concrete structures they are to be used.
 - d. Provide the admixtures recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust the quantities and types of admixtures as required to maintain quality control.
 - e. The use of Calcium chloride must not be permitted in the mix design.

L. CEMENTITIOUS WATERPROOFING

1. For Cementitious Basin Applications:

- a. Rehabilitation for existing basins, Shotcrete Dry Mix (Gunit) type basins that had no Xypex Crystalline Admix, included within the design mix and all above-grade/elevated basins:
 - 1) Water-blast the interior surface of all basins – refer to Execution Section.
 - 2) The rehabilitation of the basin's interior surface is necessary. The initial treatment must consist of a highly penetrating, highly viscous concrete densifier used as the Preliminary Pool Shell Waterproofing (PPSW).
 - 3) The PPSW must penetrate deeply into the concrete matrix on a molecular level, searching and filling out all the voids that might exist within the existing concrete structure.
 - 4) The PPSW must bond with the free Calcium and Lime within the Concrete, transforming into a dense, waterproof barrier of colloidal silicate gel.
 - 5) Achievement required:
 - a) Waterproof the surface of the concrete
 - b) Densify and strengthen the concrete
 - c) Control hydration
 - d) Exfoliate remaining entrapped salts
 - e) Assist in minimizing the reduction of rust on rebar
 - f) Reduce alkali-silica reactivity
 - 6) Applicable Standards for PPSW to meet or exceed:
 - a) ASTM D56-91 Flash Point
 - b) ASTM D-5084-91 Permeability
 - c) ASTM C-666 Freeze/thaw cycles
 - d) ASTM C-666-B – Salt Resistance
 - e) ASTM C-67 – Efflorescence
 - f) Contain no VOC's and be EPA Compliant

- 7) The Basis of Design: "BaseCrete +," as manufactured by BaseCrete Technologies, LLC, 6148 Clark Center Ave., Sarasota, FL 34238; 941.312.5142; info@BaseCreteusa.com; www.BaseCreteusa.com
- b. Cementitious waterproofing:
 - 1) After the PPSW rehabilitation process is completed, the Contractor must provide:
 - 2) BaseCrete Bondcoat must be a flexible Portland cement-based membrane coating to concrete and masonry that resists both positive and negative hydrostatic pressures and bond to the adjacent and immediate surfaces without exception.
 - a) This BaseCrete Bondcoat compound is a highly-specialized blend of aggregates, cement, graded sands, and proprietary additives. The material is to be used and mixed with the BaseCrete polymer as a waterproofing/overlay/micro-topping material.
 - 3) Benefits, Features, & Properties:
 - a) Waterproofs and decorates, tenacious bonding capacity, becomes an integral part of the substrate, durable, permanent, breathable, and extremely flexible.
 - b) Compressive Strength: 7,050 psi [48.61 MPa]
 - c) Water Vapor Transmission: ASTM E96: Passes
 - d) Pull Off: ASTM D4541.02 Surpasses
 - e) Adhesive strength on Concrete: 1,372 psi [9.46 MPa]
 - f) Adhesive Strength on Steel Plate: 1,144 psi [7.89 MPa]
 - g) Flexural Strength: 2,380 psi [16.41 MPa]
 - h) Impact Strength: 19 pounds [8.6 kg]
 - i) Tensile Strength: 732 psi [5.05 MPa]
 - j) Shear Bond Adhesion: 720 psi [4.96 MPa]
 - k) Potable Water Interface: NSF/ANSI 61-2012
Section 5: Complies
 - 4) Two coats (achieving a minimum thickness of 1/8 inch) is required to create a waterproof condition.
 - 5) The Basis of Design: BASECRETE Flexible Waterproof Bondcoat
 - a) BaseCrete Technologies, LLC, 6148 Clark Center Ave., Sarasota, Florida 34238; 941-312-5142; www.BaseCreteusa.com
2. For Tiled Applications:
 - a. Basin waterproofing for basin finishes consists of wholly tiled surfaces on pools, fountains, and water features. The material must be a thin, load-bearing waterproofing/crack isolation membrane that does not require fabric in the field, coves, or corners.
 - b. The waterproof material must be a single component, self-curing, liquid rubber polymer that forms a flexible, seamless waterproofing membrane and bonds directly to a wide variety of substrates including but not limited to concrete, concrete and brick masonry, cement mortar bed, cement screed, cement plaster, cement backer board, gunite, and shotcrete.
 - c. Limitations & Requirements:

- 1) Refer to the manufacturer for additional details, recommendations, requirements, and limitations.
- d. The Basis of Design: Laticrete HYDRO BAN by LATICRETE International, Inc. 1 LATICRETE Park North, Bethany, CT 06524-3423 USA. Phone 800-243-4788, www.laticrete.com; www.laticrete.com/green

1)

7-day tensile strength	265-psi [1.8 MPa]
7-day water immersion	95-psi [0.7 MPa]
7-day shear bond	200-psi [1.4 MPa]

M. CEMENTITIOUS MATERIALS (TROWEL-GRADE MORTAR & JOINT FILLERS)

1. Concrete radii filler (at the juncture of the basin's wall & floor), trowel-grade mortar, rehabilitation, resurfacing, and topping,
 - a. Materials
 - 1) Before mixing:
 - a) The materials must be noncombustible, both before and after the cure.
 - b) The materials must be supplied in a factory-proportioned unit.
 - c) Mortar must be placeable from 1/8-inch to 1-inch in-depth per lift for horizontal applications.
 - 2) To prepare a polymer-modified Portland cement concrete: aggregate must conform to ASTM C-33. The factory proportioned unit must be extended with 42-lb. maximum of 3/8 inches (No.8 distribution per ASTM C-33, Table II) clean, well-graded, saturated surface dry aggregate, and low absorption and high density.
 - b. Performance Criteria for the mixed polymer-modified, Portland cement mortar:
 - 1) Color: concrete gray when mixed
 - 2) Compressive Strength (ASTM C-109 Modified)
 - a) 1-day: 3,000 psi min. [20.7 mPa]
 - b) 7-days: 5,500 psi min. [37.9 mPa]
 - c) 28-days: 7,000 psi min. [48.3 mPa]
 - 3) Flexural Strength (ASTM C-293) @ 28 days: 2000 psi [13.8 mPa]
 - 4) Splitting Tensile Strength (ASTM C-496) @ 28 days 750 psi [5.2 mPa]
 - 5) Bond Strength (ASTM C-882 Modified) @ 28 days: 2200 psi [15.2 mPa]
 - 6) The Portland cement mortar must not produce a vapor barrier.
 - 7) Density (wet mix): 136 pounds / cu. feet [2.18 kg/l]
 - 8) Permeability (AASHTO T-277 @ 28 days Approximately 500 Coulombs)
 - c. The Basis of Design:
 - 1) Horizontal Surfaces: SikaTop 122 Plus, a 2-part trowel-grade mortar by Sika Corporation, is considered to conform to this specification's requirements. Sika U.S, Sika Corporation, 201 Polito Avenue, Lyndhurst, NJ 07071; 1-800-933-7452

- 2) Vertical and Overhead Surfaces: SikaTop 123 Plus, a 2-part trowel-grade mortar by Sika Corporation, may be considered to conform to this specification's requirements. Sika U.S, Sika Corporation, 201 Polito Avenue, Lyndhurst, NJ 07071; 1-800-933-7452; www.usa.sika.com
2. Thick bed mortar & Screed Coat
 - a. This mortar is a polymer fortified blend of carefully selected polymers, Portland cement, and graded aggregates suitable for bonded and non-bonded thick bed mortar applications, conventional thick bed mortar applications, and suitable concrete repairs
 - 1) For use in interior and exterior applications, wet and dry applications
 - 2) This specialty mortar does not require latex admix, as the installers only need to add prescribed water to produce a thick bed mortar with exceptional strength.
 - 3) For use as a scratch or thick bed screed coat, but it is not a waterproofing product and must be combined with the listed waterproofing products within This Specification.
 - 4) This product is intended for use as a family of compatible products by one manufacturer.
 - b. The specialty mortar must be:
 - 1) Polymer fortified (not needing latex additives)
 - 2) Premixed requiring no job site blending of powders required
 - 3) Economical – saves time and money
 - 4) Incorporate a high strength formula
 - 5) Capable of use in pumpable applications for large scale veneer projects
 - 6) Exceeds ASTM C270 requirements
 - c. Physical Properties

1) Water Absorption	ANSI A118.7.3.4	5%
2) 28-Day Compressive Strength	ASTM C270	4000–5000 psi [27.6–34.5 MPa]
3) Flexural Strength	ANSI A118.7.3.5	1100–1200 psi [7.5–8.3 MPa]
4) Shrinkage 7 Day Cure	ASTM C-157	0.05%
5) TCNA Service Rating	ASTM C-627	Extra Heavy
 - d. The Basis of Design: 3701 Fortified Mortar, Sika Corporation, 201 Polito Ave., Lyndhurst, NJ 07071 USA, 800.933.7452; www.usa.sika.com
3. Crack Joint Filler
 - a. For use on static and dynamic joints (or cracks that are opened to allow sealing)
 - b. Observe manufacturers' recommendations and installation procedures.
 - c. The Basis of Design: Sika Duoflex NS, Sika Corporation, 201 Polito Ave., Lyndhurst, NJ 07071 USA, 800.933.7452; www.usa.sika.com
4. Concrete patching and overlay
 - a. A one-component, pourable, rapid hardening, Portland-cement concrete containing factory blended coarse aggregate designed for quick turnaround, overlay needs, and formulated to compensate for shrinkage
 - b. Uses:

- 1) Structural repair on horizontal, vertical, and overhead surfaces (formed)
- 2) On-grade, above, and below grade on concrete
- 3) Full-depth repairs and a filler for voids and cavities

c. Typical properties:

Item #	Property	Curing Time	PSI	MPa
1	Flexural Strength	28 days	700	5.0
2	Bond Strength	1 days	2,500	17.2
3	Bond Strength	7 days	3,000	20.7
4	Compressive Strength	2 hours	2,500	17.2
5	Compressive Strength	1 days	5,000	34.5
6	Compressive Strength	28 days	7,500	51.7

- d. The Basis of Design: Sikacrete 321 FS, Sika Corporation, 201 Polito Ave., Lyndhurst, NJ 07071 USA, 800.933.7452; www.usa.sika.com

N. LINK-SEALS, WATERSTOPS, & WATERPROOF PENETRATIONS

1. Pre-fabricated water stops:

- a. PVC Piping Waterstop Coupling: A circular PVC plate fabricated, or factory welded to PVC pipe couplings must form the water stop.
 - 1) The PVC, Sch. 80 plate-material, must have an outside diameter of 2-inches [50 mm] larger than the pipe coupling diameter. Refer to the manufacturer for final dimensions.
 - 2) Waterstop plate thickness: 0.50-inch [13 mm] or greater. For “hot-air” PVC welding, the water stop plate must be fillet-welded on both sides of the plate.
 - 3) The integral use of PVC couplings must allow the socket welding of pipes into the piping water stop couplings.
 - 4) The Basis of Design:
 - a) W02 through W18 (2 through 18-inches [50 through 457 mm]) by Neptune Benson; www.neptunebenson.com; 800.832.8002
 - b) Daldorado, LLC., Ph: (888) 509-8128, 4327 Arnold Ave, Naples, FL 34104; www.daldorado.com
- b. Metallic Water stops at Pipe Coupling: Sizes the same as the PVC unit, except using arc welding of the water stop plate (with constant materials) to the metallic pipe coupling.
- c. Waterstop Fittings – Sleeve Design
 - 1) Waterstop Fittings are available in PVC and slide over the exterior of either 1.5-inches [25 mm] or 2-inches [50 mm] Schedule 80 PVC (ADE Type 2) pipe. The units are cemented (primed and glued) in place per these specifications’ requirements in Piping.
 - 2) Fittings must incorporate alignment holes, enabling them to be secured to the adjacent rebars to confirm exact alignment and penetration.
 - 3) The Basis of Design:

- a) Model "PVC-40-301" for 1.5-inches [25 mm] piping
 - b) Model "PVC-40-302" for 2-inches [50 mm] piping
 - c) A.S.A. Manufacturing, Inc. 14879 SW 111th St., Dunnellon, FL 34432, USA, 800-827-7665, www.asamfg.com
- d. Fiberglass Waterstop Couplings
 - 1) Fiberglass Waterstop Couplings are required for pipe sizes available in sizes starting at 1-inch [25 mm] through 20-inches [500 mm].
 - 2) Incorporate a rough exterior sand finish factory-welded to a PVC Sch 80 (ADE Type 2) fitting at the manufacturer's facilities.
 - a) Critical: PVC Sch 40 (ADE Type 1) are NOT allowed.
 - 3) A manufacturer's certified factory-assembly workmanship quality must accompany each fitting assembly (see Submittals).
 - 4) The Basis of Design:
 - a) A.S.A. Manufacturing, Inc. 14879 SW 111th St., Dunnellon, FL 34432, USA, 800-827-7665, www.asamfg.com
- 2. Link-Seals assemblies:
 - a. Sleeve features:
 - 1) Molded from non-conductive, light-weight, high impact-resistant HDPE available in diameters ranging from 2-inches [25 mm] to 25-inches [635 mm] in any length.
 - 2) Hollow waterstop collar: 2-inches [50 mm] width.
 - 3) Provide specially designed end caps for attaching the sleeves to the concrete forms and assuring the sleeve holds the circular configuration during the concrete placement.
 - 4) Provide sleeve with a textured exterior surface to assure a better mechanical bond to the concrete interfaces.
 - 5) The Basis of Design: Century Line thermoplastic wall sleeves by Thunderline/Link-Seal, 6525 Goforth Street, Houston, TX 77021, 713.747.6948, www.linkseal.com or a pre-approved equal.
 - b. Link-Seal Modular Seals with the following features:
 - 1) Model "S-316L" Link-Seal Modular Seal
 - a) Suitable for use in water, direct-ground burial, mild chemical exposure, and the atmospheric pressure
 - b) Must provide electrical isolation and cathodic protection
 - c) EPDM ("black" in color) with reinforced nylon polymer pressure plates
 - d) Nuts, bolts, and washers must be ANSI type stainless steel grade 316L, per ASTM F593-95 with a tensile strength of 85,000 psi, minimum
 - c. The Basis of Design: Link-Seal assemblies (by PSI-Thunderline/Link-Seal), 6525 Goforth Street, Houston, TX 77021, 713.747.6948, www.linkseal.com or a pre-approved equal.
- 3. PVC water stops for moving expansion joints
 - a. Provide flexible PVC (polyvinyl chloride) water stop by Sika Greenstreak, profile style, as indicated in the Drawings.

- 1) The PVC water stop must be extruded from elastomeric plastic material, of which the core resin is prime virgin polyvinyl chloride.
- 2) The PVC compound must not contain any scrapped or reclaimed material or pigment whatsoever.
- 3) The natural color of prime virgin polyvinyl chloride is an off-white, milky color.

b. Performance requirements are as follows:

Property	Test Method	Specified Limits
Water absorption	ASTM D 570	0.15% max
Tear Resistance	ASTM D 624	300 lb./in (0.339 kN/m) min.
Ultimate Elongation	ASTM D 638	350% min.
Tensile Strength	ASTM D 638	2000 psi (13.78 Mpa) min.
Low-Temperature Brittleness	ASTM D 746	No Failure @ -35° F (-37° C)
Stiffness in Flexure	ASTM D 747	700 psi (4.82 Mpa) min.
Specific Gravity	ASTM D 792	1.38 max.
Hardness, Shore A	ASTM D 2240	79 \pm 3
Tensile Strength after accelerated extraction	CRD-C 572	1600 psi (11.03 Mpa) min.
Elongation after accelerated extraction	CRD-C 572	300% min.
Effect of Alkalies after 7 days: Weight Change Hardness Change	CRD-C 572	between -0.10% / +0.25% +/- 5 points

4. Hydrophilic water stop for non-moving contraction and construction joints

a. The Basis of Design:

- 1) Hydrophilic rubber water stop as supplied by Sika Greenstreak, HYDROTITE profile style number CJ-0725-3K-ADH; www.usa.sika.com.
- 2) Alternate pre-approved material: SF302 Synko-Flex as manufactured by Henry Company 999 N. Sepulveda, Ste 800, El Segundo CA 90245-2754; (800) 486-1278; www.henry.com

b. The water stop must be a combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.

- 1) Products containing Bentonite are prohibited.

c. The water stop must have a delay coating to inhibit initial expansion due to fresh concrete moisture.

d. Performance requirements as follows:

- 1) Chloroprene Rubber

Property	Test Method	Specified Limits
Tensile Strength	ASTM D 412	1300 psi min.
Ultimate Elongation	ASTM D 412	400% min.
Hardness (Shore A)	ASTM D 2240	50 \pm 5

Tear Resistance	ASTM D 624	100 lb./inch min.
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2) Modified Chloroprene (Hydrophilic) Rubber

Property	Test Method	Specified Limits
Tensile Strength	ASTM D 412	350 psi min.
Ultimate Elongation	ASTM D 412	600% min.
Hardness (Shore A)	ASTM D 2240	52 +/- 5
Tear Resistance	ASTM D 624	50 lb./inch
Expansion Ratio	Volumetric Change - Distilled Water @ 70° F	3 to 1 min.

5. PVC water stop accessories

- Provide factory-made water stop fabrications for changes of direction, intersections, and transitions leaving only straight butt joint splices for the field.
- Provide field-installed hog rings, or factory-installed punched holes or grommets spaced at 12-inches [305 mm] on center along the water stop length.
- Provide Teflon coated thermostatically controlled water stop splicing irons for field butt splices.

6. Hydrophilic Waterstops

- Peel and Stick Adhesive Backing: HYDROTITE ADH - Two-Component Epoxy Gel: Greenstreak 7300
- Single Component Hydrophilic Sealant: LEAKMASTER
- Cyanoacrylate Adhesive (Super Glue): As recommended by the water stop manufacturer

O. DECK TO POOL BEAM & MISCELLANEOUS SEALANTS

- Deck sealant (between the deck and pool beam) must be Deck-O-Seal One Step or Sikaflex 12-SL. Deck-O-Seal: Hampshire, IL (800-542-7665); www.deckoseal.com. The Sika Corporation: Lyndhurst, NJ (210-933-8800); www.usa.sika.com.

P. UNDERWATER SEALANTS

- The Basis of Design for underwater expansion joints for Contractor or pool installer:
 - Submerseal by EMSEAL Joint Systems, LTD; 25 Bridle Lane; Westborough, MA 01581-2603; 800-526-8365. www.emseal.com.
 - Willseal 250BG by Willseal LLC, 34 Executive Drive, Hudson, NH 03051, 800-274-2813, 800-416-0550 (Fax), www.Willseal.com; email: custserv@Willseal.com
 - Available in color "gray."
 - Joint widths: 0.5-inch to 4-inches [13mm to 100mm]
- The Basis of Design for underwater expansion joints for Manufacturer Certified Joint Installer. The below-mentioned materials are pre-approved subject to the materials being installed by a manufacturer's Certified Joint Installer.

- a. Horizontal underwater construction/expansion joints: “Dura-White” Deck-O-Seal #125 by Deck-O-Seal Corporation, Hampshire, IL (800-542-7665);
www.deckoseal.com.
- b. Vertical underwater construction/expansion joints: “Dura-White” Deck-O-Seal Gun Grade by Deck-O-Seal Corporation, Hampshire, IL (800-542-7665);
www.deckoseal.com.
3. Waterproof Permanent Seam and Gap Fillers for swimming pools must be professional-grade sealants specially engineered to work similar to silicone caulk, but manufacturer certified to have permanent flexibility.
 - a. Sealant must be of high viscosity, non-sag, making sealant “stay put” even on vertical surfaces, and provide a permanent solution for bonding to surfaces such as glass, acrylic, aluminum, wood, masonry, ceramics, plexiglass, fiberglass, vinyl, and stainless steel. The manufacturer must provide written authorization for use:
 - 1) Use in either wet or dry environments, including swimming pools, spas, and standing water on concrete
 - 2) Use glass & acrylic panels or glass blocks to make a non-structural, watertight seal
 - 3) Use to seal stainless steel pools & pool gutters
 - 4) Use between pool tile & bond beam trim as a permanently waterproof, flexible gap filler
 - 5) Use to seal the gap between the concrete pool bottom and the vinyl liner or poly panels
 - b. The minimum product features must include:
 - 1) Gap & Seam filler for swimming pools & spas,
 - 2) Provide a waterproof, flexible, permanent repair,
 - 3) include application temperatures as low as 32 deg-F,
 - 4) certified for use on vertical, horizontal, or sloping surfaces, mild chlorine & chemical resistance, and
 - 5) contain UV inhibitors for above-water applications.
 - c. Basis of Design: ABC-9100-300 (Clear) and ABW-9000-300 (White), by AquaBond, LLC, 6444 E. Spring Street #275, Long Beach, CA 90815-1553; 714-961-1420;
www.aquabond.com
 - d. Basis of Design for thin filling & small cracks: AFC-8100 (Clear) and AFW-8000 (White), by AquaBond, LLC, 6444 E. Spring Street #275, Long Beach, CA 90815-1553; 714-961-1420; www.aquabond.com

Q. ADHESIVES & GROUTS

1. General
 - a. A single manufacturer’s products (a compatible family of products) are mandatory unless specifically approved in writing by This Engineer.
2. Adhesives for the exterior, underwater, and submerged applications
 - a. Rated by the manufacturer as:
 - 1) superior for the exterior, submerged, and underwater applications
 - 2) ultimate adhesion for porcelain and glass tiles

- b. The Basis of Design: Latex Portland Cement Thin Bed Mortar for thin-set and slurry bond coats: Weather, frost, and shock-resistant, non-flammable, GreenGuard compliant, conform to ISO C2TES1, and meeting the following physical requirements:
 - 1) Shear bond in water immersion: > 300 psi [2.0 MPa]
 - 2) 7-Day curing / 21-day water immersion
Tensile adhesion strength: > 170 psi [1.17 MPa]
 - 3) Total VOC Content < 0.05 mg/m³
- c. Latex Portland cement Thin Bed Mortar: use LATICRETE 254 Platinum by LATICRETE International, Inc. 1 LATICRETE Park North, Bethany, CT 06524-3423 USA. Phone 800-243-4788, www.laticrete.com; www.laticrete.com/green
3. Adhesives for spot bonding method of tile and stone installations
 - a. Rated by the manufacturer as:
 - 1) High strength epoxy adhesive formulated for spot bonding method of tile and stone installation on vertical and overhead surfaces for exterior applications
 - 2) Adhesive for fabricating granite, marble, and stone
 - b. The Basis of Design: LATAPOXY 310 Stone Adhesive for a fast, permanent bond, non-staining, resistant to shock and vibration, non-sag, conform to ANSI A118.3, ISO 13007, and EN 12004, and meeting the following physical requirements:
 - 1) Shear bond to concrete: 720 to 920 psi [5.0 to 6.3 MPa]
 - 2) Tensile adhesion strength: 1,500 to 2,100 psi [10.3 to 14.5 MPa]
 - 3) 7-day cure shear adhesive strength 2,610 to 4,785 psi [18 to 33 MPa]
 - 4) 7-day cure 21-day water immersion
shear adhesive strength 2,030 to 4,930 psi [14 to 34 MPa]
 - 5) Thermal shock 1,030 to 1,600 psi [7 – 11 MPa]
4. Epoxy Grout
 - a. Only epoxy grouts in tiles or natural stone finishes are permitted
 - b. The Basis of Design: Laticrete SpectraLOCK PRO Premium Grout by LATICRETE International, Inc. 1 LATICRETE Park North, Bethany, CT 06524-3423 USA. Phone 800-243-4788, www.laticrete.com; www.laticrete.com/green
 - 1) Compressive Strength: 3,800 psi (@7 days) [26.2 MPa]
 - 2) Tensile Strength: 1,100 psi (@7 days) [7.6 MPa]
5. Epoxy adhesive anchoring of reinforcing steel
 - a. The Basis of Design: "HIT-HY 200 Epoxy Adhesive Anchoring System", by Hilti.
 - 1) Utilizing a #4 grade 60 deformed bar dowels with an embed depth of 4.5-inches [114.3 mm] into existing 4,000 PSI [27.58 mPa] existing concrete, the following performance must be attained with a 7-day cure:
 - 2) Bond strength (per ASTM C882-91): 18,540 psi [127.82 mPa]
 - 3) Compressive strength (per ASTM D-695-96): 12,000 psi [82.74 mPa]
 - 4) Tensile strength (per ASTM D-638-97): 6,310 psi [43.51 mPa]
 - 5) Yield strength (as limited by grade 60 bars): 12,000 pounds [5443.1 kGrams]
 - 6) Tensile strength (as limited by grade 60 bars): 18,000 pounds [8164.7 kGrams]

- b. The adhesive must be furnished in side-by-side refill packs, which keep component A and component B separate. Side-by-side packs must be designed to compress during use to minimize waste volume.
 - c. Side-by-side packs must also be designed to accept a static mixing nozzle, which thoroughly blends component A and component B and allows injection directly into the drilled hole.
 - d. Injection adhesive must be formulated to include resin and hardener to provide optimal curing speed and high strength and stiffness. Typical curing time at 68°F (20°C) must be approximately 12-hours.
6. Non-Shrink Grout
- a. High-precision, non-shrink mineral, aggregate grout
 - 1) Cement-based, non-metallic, & nonshrink
 - b. One-component – ready to mix and use
 - c. Fluid, flowable, plastic, & damp-pack consistencies
 - d. Nonshrinking - Leaves no gaps in equipment and forms
 - e. Compressive strength @ 7=days: 6,500 PSI [45 MPa]
 - f. The Basis of Design: Masterflow 713-Plus, by BASF Construction Chemicals, 889 Valley Park Drive, Shakopee, MN, 55379, www.BuildingSystems.BASF.com or Engineer-approved equal.

2.02 SHOTCRETE WET-MIX PRODUCTS

A. GENERAL

- 1. All shotcrete must be considered structural.

B. MATERIALS

- 1. Cement: ASTM C150, Type 1 - Normal - gray color.
- 2. Normal Weight Aggregate: ASTM C33, 3/8-inch [9.5 mm].
- 3. Water: Potable, clean, and not detrimental to shotcrete wet-mix.
- 4. Alignment Wire: High strength steel wires used for the alignment of shotcrete.
- 5. Crystalline Concrete Waterproofing Admixture: As specified in the CAST-IN-PLACE READY-MIX CONCRETE PRODUCTS section.

C. SHOTCRETE WET-MIX DESIGN

- a. Conform to the following requirements:
 - 1) Compressive Strength (28 days): 4,000 psi [27.58 mPa] minimum
 - b. Aggregate and Water: Proportioned to achieve mix design.
 - c. Aggregate Size (maximum): 3/8-inch [9.5 mm]
 - d. Air Entrainment: No admixtures allowed without specific approval
 - e. Shotcrete wet-mix Slump: As required by contractor to properly shoot the concrete.
- 2. The selected Ready-Mix supplier's Specialty Designated Engineers must provide the design mix.

- a. The contractor's water-cement ratio must not exceed 0.45 unless pre-approved by This Engineer.
3. Develop a mix-design to give proper compaction and a low percentage of rebound and stiff sufficient not to sag.
4. Approved admixture materials must be per the manufacturer's instructions & recommendations
5. Thoroughly mix shotcrete wet-mix. Apply mix within 90 minutes of adding Portland cement to the mix.
 - a. When the air temperature is between 85 deg F [29 deg C] and 90 deg F [32 deg C], reduce mixing and delivery time from 90 minutes to 75 minutes, and when the air temperature is above 90 deg F [32 deg C], reduce mixing and delivery time to 60 minutes.
6. The combined aggregate gradation must comply with grading No. 2 of ASTM C1436.
7. Maintain quality control records (including concrete delivery tickets) during production and application of shotcrete wet-mix. Records must include an exact mix-design ID number, including admixes, arrival time, load off-load time, water added, and departure time.
 - a. Only the Concrete Supplier Batch Plant may add water to the design mix.
 - b. No water must be added after departing the batch plant

D. SHOTCRETE WET-MIX APPLICATION EQUIPMENT

1. Mixing Equipment: Capable of mixing aggregate, cement, and water in sufficient quantity to maintain continuous placement.
2. Delivery Equipment: Capable of discharging the wet mix aggregate, cement, and water to meet performance requirements.

E. SHOTCRETE WET-MIX SOURCE QUALITY CONTROL

1. Provide inspection and testing to verify conformance to design mix specifications and a finished product that meets or exceeds Grade 2 in quality.
2. Test panels must be provided per the following:
 - a. Prepare test panels per ASTM C1140.
 - b. Perform compressive tests on panels per ASTM C1140 and determine acceptability per ACI 506.2.
 - c. If test panels are not available for compressive testing, compressive testing of cores must be performed per ASTM C1604, with the cores' locations being chosen by the structural engineer.
3. Provide one set of pre-construction test panels for each nozzleman before performing work on the actual project. Only nozzlemen who have produced satisfactory pre-construction test panels must be allowed to work on the project.
4. The shotcrete wet-mix applied material must be kept in a dampened state for a minimum of 7-days continuous.
5. No shotcrete wet-mix may be placed directly onto soils unless a vapor barrier or steel-text fabric is provided to prevent concrete from contacting earth.
6. Nozzlemen must be certified per ACI 506.3R

7. Do not apply shotcrete wet-mix when ingredients or the reinforcing steel exceed 100 degrees Fahrenheit.
8. Tolerances must not exceed twice that specified in ACI 117

2.03 CAST-IN-PLACE READY-MIX CONCRETE PRODUCTS

A. MATERIALS

1. Portland cement: ASTM C 150, Type I or ASTM C 595, Type 1L.
 - a. The Contractor shall use only one brand of cement throughout the Project.
2. Fly Ash: ASTM C 618, Type F, may be substituted for up to 25 percent of the total cementitious material content.
3. Slag: ASTM C 989 may be substituted for up to 40 percent of the total cementitious material content.
4. Standard Weight Aggregates: ASTM C 33 and as specified.
 - a. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
 - b. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by individual tests or actual service may be used after explicit approval by This Engineer.
 - c. Fine Aggregate: Use clean, sharp, natural sand free from loam, clay lumps, or other deleterious substances. The maximum sand to total aggregate ratio shall be 0.50.
 - d. Coarse Aggregate: Clean, un-coated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
 - 1) Mix design(s) shall include both #89 and #57 coarse aggregates and be well gradated.
 - 2) Crushed stone is processed from natural-rock or stone.
 - 3) Washed gravel, either natural or crushed stone. The use of pit or bank-run gravels is not permitted.
 - 4) Maximum Aggregate Size: Sizes not larger than one-fifth of the narrowest dimension between sides of the forms, one-third of the depth of slabs, nor three-fourths of minimum clear spacing between individual reinforcing bars or bundles of bars.
 - 5) Aggregate Supply: Provide aggregates from only one source of supply to verify uniformity in color, size, and shape.
5. Water: Potable only, clean, and not detrimental to cast-in-place concrete.

B. CAST-IN-PLACE CONCRETE READY-MIX ADMIXTURES

1. Provide admixtures produced by listed manufacturers and use them in compliance with the manufacturer's printed directions. Do not use any admixtures which have not been incorporated and tested in accepted mixes unless otherwise explicitly authorized in writing by This Engineer.
 - a. Cementitious Crystalline Concrete Waterproofing: Mandatory component in all vessel-related concrete holding water and must be leakproof.
 - b. Air-Entraining Admixture: ANSI/ASTM C260
 - c. Water-Reducing Admixture: ANSI/ASTM C494, Type A.

- d. Super Plasticizer: ANSI/ASTM C494, Type F.
- e. Set-Control Admixture: ANSI/ASTM C494
- 2. Cementitious Crystalline Concrete Waterproofing:
 - a. Xypex Admix Type C-500-NF or C-1000-NF (as recommended by the manufacturer for the specific mix(es) being used) by Xypex crystalline waterproofing materials as follows:
 - 1) Utilize this additive formula unless noted otherwise in the drawings or these specifications.
 - 2) Dosage Rate (for this Admix only):
 - a) 1.25% by weight of Portland cement content
 - b. Alternate, approved formulation: Xypex type C-500 and C-1000.
 - 1) Dosage Rate (for this Admix only):
 - a) 2.50% by weight of Portland cement content
 - c. A concrete waterproofing system must be of the crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure throughout the concrete's capillary voids.
 - d. The system must cause the concrete to become sealed against liquids' penetration from any direction and protect the concrete from deterioration due to harsh environmental conditions.
- 3. Air Entraining Admixture: Such products must comply with ASTM C 260 and be certified by the manufacturer to be compatible with other specified admixtures. In warm climates where frost-proof concrete is not necessarily due to freezing and thawing cycles, no air-entraining agent must be used in the floor slab mix design(s) to prevent the surface's blistering paste.
 - a. Subject to compliance with the requirements, provide one of the following:
 - 1) "AEA-92 and Air Mix 200", Euclid Chemical Co.
 - 2) "MB VR or MB-AE," Master Builders, Inc.
 - 3) "Sika AER," Sika Corp.
- 4. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.05 percent chloride ions.
 - a. Subject to compliance with the requirements, provide one of the following:
 - 1) "Eucon WR-75 or Eucon WR-91," Euclid Chemical Co.
 - 2) "Pozzolith Normal," Master Builders, Inc.
 - 3) "Plastocrete 160," Sika Corp.
- 5. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F or Type G containing not more than 0.05% chloride ions.
 - a. Subject to compliance with the requirements, provide one of the following:
 - 1) "Eucon 37", Euclid Chemical Co.
 - 2) "Rheobuild 1000", Master Builders, Inc.
 - 3) "Sikament 300", Sika Corp; www.usa.sika.com

6. Water-Reducing, Accelerating Admixture: Non-chloride, non-corrosive per ASTM C 494, Type C, or E, and not contain more chloride ions present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures.
 - a. Subject to compliance with the requirements, provide one of the following:
 - 1) "Accelguard 80", Euclid Chemical Co.
 - 2) "Pozzutec 20", Master Builders, Inc.
7. Water-Reducing & Retarding Admixture: ASTM C-494, Type D, containing no more than 0.05 percent chloride ions.
 - a. Subject to compliance with the requirements, provide one of the following:
 - 1) "Eucon Retarder 75", Euclid Chemical Co.
 - 2) "Pozzolith Retarder," Master Builders, Inc.
 - 3) "Plastiment," Sika Corporation.
8. Prohibited Admixtures: Calcium chloride or admixtures containing more than 0.05 percent chloride ions.

C. CAST-IN-PLACE CONCRETE READY-MIX DESIGN

1. Conform to the following requirements for:
 - a. Vessels that hold water, including their cast-in-place copings (if any):
 - 1) Compressive Strength (28 days): 4,000 psi [27.58 mPa] minimum
 - 2) Water-Cementitious Materials (w/cm) Ratio: The concrete mix must have a maximum w/cm ratio of 0.45. Mixes must comply with Chapters 3, 4, and 5 of ACI 318 latest building code adopted edition.
 - 3) Slump: As required by the contractor to properly place and consolidate the concrete.
 - 4) Aggregate Sizes: #89 and #57
 - 5) Drying Shrinkage: Maximum ultimate drying shrinkage shall be 0.052%, which must be verified by following the ACI 209R using 28-day laboratory shrinkage values (7 days of curing and then 21 days of air storage). Historical data or engineering data may be submitted for review as justification that this requirement has been met in place of following the ACI 209R procedure. The intent is that low-shrinkage concrete must be used for vessels and related coping units to minimize shrinkage cracking.
 - 6) Additional Requirements: Refer to the concrete exposure category and concrete class listed in the Drawings, and provide concrete mix(es) as required by ACI 318.
 - b. Non-Vessels (e.g., housekeeping equipment pads, underground pre-fabricated fiberglass tank foundations, railing anchors, ADA lift anchors, and the like):
 - 1) Compressive Strength (28 days): 3,000 psi [20.68 mPa] minimum
 - 2) Water-Cementitious Materials (w/cm) Ratio: The concrete mix shall have a maximum w/cm ratio of 0.55. Mixes must comply with Chapters 3, 4, and 5 of ACI 318 latest building code adopted edition.

3) Slump: As required by the contractor to properly place and consolidate the concrete.

4) Aggregate Sizes: #89 and #57

2. The selected Ready-Mix supplier's Specialty Designated Engineers must submit the mix design(s) for review.
3. Proportion mixes by either laboratory trial batch or the field-experience methods specified in ACI 301, using materials employed on the project for each class of concrete specified.
4. Adjustment to Concrete Mixes: Mix design-adjustments may be requested by the contractor when characteristics of materials, job conditions, weather, testing results, or other circumstances warrant, at no additional cost to the Owner and as accepted by This Engineer. Laboratory test data for revised mix designs & strength results must be submitted to and accepted by This Engineer before using it.
5. Prepare the design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods, per ACI 301. For the trial batch method, use an independent testing agency acceptable to This Engineer to prepare and report proposed mix designs. Trial batch and field experience tests must have been performed within 12 months of the submittal date.

D. CAST-IN-PLACE CONCRETE READY-MIX SOURCE QUALITY CONTROL

1. Cooperate & coordinate with the testing laboratory to perform field quality control testing during the concrete installation.
2. Refer to the testing procedures and requirements within these specifications.

2.04 SHOTCRETE DRY-MIX (GUNITE) PRODUCTS

A. GENERAL

1. The use of Shotcrete Dry-Mix (GUNITE) is disallowed unless strict compliance with the below is met.
2. All shotcrete must be considered structural.

B. MATERIALS

1. Cement: ASTM C150, Type 1 - Normal - gray color.
2. Normal Weight Aggregate: ASTM C33, 3/8-inch [9.5 mm] maximum size.
3. Compressive Strength: Refer to the Shotcrete dry-mix requirements.
4. Water: Water must be potable and clean (but not detrimental to shotcrete dry-mix).
5. Alignment Wire: Small gauge, high strength steel cables & wires.

C. SHOTCRETE DRY-MIX DESIGN

1. Aggregate and Water: Proportioned to achieve mix design.
2. Conform to the following requirements:
 - a. Compressive Strength (28-day minimum): 5,000 psi [34.47 mPa]
 - b. Aggregate Size (maximum): 3/8-inch [9.5 mm]
 - c. Air Entrainment: No admixtures allowed without specific approval

3. The Contractor's Specialty Designated Engineers must provide the design mix due This Engineer's review. A design mix with a maximum water-cement ratio of 0.35 must be attained.
4. Develop a mix design to give proper compaction and a low percentage of rebound and stiff sufficient not to sag.
5. Approved admixture materials must be per the manufacturer's instructions & recommendations.
6. Thoroughly mix shotcrete dry-mix. Apply mix within 45 minutes of batching or pre-dampening.
7. The combined aggregate gradation must comply with grading No. 2 of ASTM C1436.
8. Maintain quality control records during production and application of shotcrete dry-mix; make records available. Maintain and record such items as arrival time, water added, times work ceased, etcetera.

D. SHOTCRETE DRY-MIX APPLICATION EQUIPMENT

1. Mixing Equipment (for shotcrete dry-mix): Capable of thoroughly mixing aggregate and cement in sufficient quantity to maintain continuous placement.
2. Delivery Equipment (for shotcrete dry-mix): Capable of discharging dry mix aggregate and cement accurately, uniformly, and continuously.

E. SHOTCRETE DRY-MIX SOURCE QUALITY CONTROL

1. Provide inspection and testing to verify conformance to design mix specifications and a finished product that meets or exceeds Grade 2 in quality.
2. Test panels must be provided per the following:
 - a. Prepare test panels per ASTM C1140.
 - b. Perform compressive tests on panels per ASTM C1140 and determine acceptability per ACI 506.2.
 - c. If test panels are not available for compressive testing, compressive testing of cores must be performed per ASTM C1604, with the cores' locations being chosen by the structural engineer.
3. Provide one set of pre-construction test panels for each nozzleman before performing work on the actual project. Only nozzlemen who have produced satisfactory pre-construction test panels must be allowed to work on the project.
4. The shotcrete dry-mix applied material must be kept in a dampened state for a minimum of 7-days continuous.
5. No shotcrete dry-mix may be placed directly onto soils unless a vapor barrier or steel-text fabric is provided to prevent concrete from contacting earth.
6. Nozzlemen must be certified per ACI 506.3R
7. Do not apply shotcrete dry-mix when dry mix ingredients or the reinforcing steel exceed 100 degrees Fahrenheit.
8. Tolerances must not exceed twice that specified in ACI 117

2.05 NOT USED

2.06 PIPING & FITTINGS

A. PIPE & FITTINGS MATERIAL TYPES

1. The following types of piping & fittings are identified below based upon their location, materials, & purpose.
 - a. The fittings must be the same pipe type and schedule.
2. Unless noted otherwise, the piping must be NSF-PW-rated. The NSF-PW rating assures that the materials are individually listed and approved for potable water use.
3. Type 1 and Type 2 pipe may be substituted with UPVC in the same pressure rating.

MARTIN AQUATIC PIPE & FITTINGS TYPE	MATERIALS	REMARKS
TYPE 1	PVC, SCHEDULE 40	No threaded fittings are allowed in Sch.40. All threaded fittings must be Type 2, Sch. 80
TYPE 2	PVC, SCHEDULE 80	
TYPE 3	CPVC, SCHEDULE 80	Utilize CPVC TYPE IV
TYPE 4	HDPE - SDR-11, PN-16	
TYPE 5	Stainless Steel, Schedule 10, Grade 304 (or better)	Welded pipe and pipe fittings
TYPE 6	Coated Galvanized Steel, Grade 40	Must include a coating for chemical resistance
TYPE 7	Clear PVC, Schedule 80	
TYPE 8	PVC, Schedule 80, Double-walled Containment Piping	A. For hard-pipe transport of sodium hypochlorite (bleach) and muriatic acid B. Primary pipe-carrier 2-inches [50mm] and secondary containment 4-inches [100mm]
TYPE 9	Corrugated HDPE pipe	For Drain, Vent, Waste, & Sleeves, under-roadways (must meet Federal Highway loading for H-10).
TYPE 10	PVC, Flexible	The specified length must be entirely sealed/wrapped in direct-burial insulation & water-proof jacketing

B. PIPING SCHEDULES / APPLICABILITY / USES

1. Pipe materials must be as follows. Fittings must be the same schedule as the piping:

Description:	ADE Type Pipe:	Remarks:
Air blower piping (small loads/pressures only) (initial 90-feet [27.4 M])	5	Must include closed-cell insulation within the equipment room. Place signage "HOT – DANGER."
Air blower piping (small loads/pressures only) (<u>after</u> initial 90-feet [27.4 M])	3	Must include closed-cell insulation for exposed piping, typical for blower-induced air supply for therapy fittings or similar use. Add closed-cell insulation on exposed piping
Air compressor & regenerative blower piping >30 psi [2 Bars]	5	The entire piping system for compressed air to be St. steel, as indicated above (Type 5); must include closed-cell insulation on all exposed piping
Air tubing/hoses within conduits and chases (for applications such as air supply tubing for pneumatic valves)	1	Must include long sweep fittings specified to facilitate the install of tubing. Black color for tubing/flex pipe; air tubing must be UV outdoor-rated.
Chemical tubing conduits or chases	1	Long sweep fittings are specified to facilitate the install of tubing.
Chlorine or acid transport	8	Must place such piping within Type 6 below-grade sleeves for additional protection. (Double-walled thermoplastic piping containment below grade).
Clear piping to observe the water flow in designated pipe locations	7	Must include a minimum length of 24-inches [600 mm] or as noted in Drawings. Utilize before flow meters, waste discharge pipes and similar equipment Provide pipe supports to prevent sagging.
Concealed piping & Fittings	1	For sizes 6-inches [150 mm] or less
Concealed piping & fittings	2	For sizes 8-inches [200 mm] or greater
Exposed fountain pipe	10	For visible connections in the fountain when flex pipe is conducive to relocating nozzles and angular adjustments. Without exception, the flex pipe color MUST match the color of the basin's interior finish.
Exposed pipe & fittings	2	Above-grade within equipment rooms except as noted herein
Flexible Joints	1,2,7, & 10	Flexible connectors (for pipe sizes up to 12-inches [305 mm] must be located. Refer to FLEXIBLE CONNECTORS within these specifications.

Flexible piping	10	Pipe sizes up to 3-inch [75 mm] must use a 5-ft [1.3 M] length of flexible pipe at the positions noted in the Drawings.
Heater piping	3	Must be fully supported – refer to the heater manufacturer to determine if Type 5 is expressly specified.
Pipe & fittings beneath basin structures	2	Without exception – since these pipes are inaccessible after construction.
Piping & valve manifolds	5	Must include trunk pipe with numerous valve branches – each connection must be flanged. Utilize the flange to convert to other types of pipe material
Piping beneath roadways, traffic areas, beneath building footers, or piping exposed to heavy loads	2 (placed within Type 6 or Type 9 oversized sleeve)	Must install Type 2 piping within Type 6 or Type 9 piping (being used as an oversized sleeve) sized and installed per the manufacturer's requirements for the depth of earth cover. Utilize the H-10 load rating.
Piping passing through multiple structures	5	Pipe passing through two or more layers of concrete – all pipe sizes
Piping passing through a single structure	2	Pipe passing through a single layer of concrete only – all pipe sizes
Threaded Fittings	2	All threaded fittings (Male adaptors and Female adapters) must be Type 2

2. Piping General Notes / Requirements

- a. Provide closed-cell insulation (rated for high temperatures up to 240° F [115° C.]) around chilled, heated, & compressed air piping.
 - 1) Compressed air piping must include closed-cell installation unless located beneath 18-inches [455 mm] of soil.
- b. UV inhibitor coating on piping & fittings: Types (1 through 4 and type 8) Plastic (petrochemical) piping & fittings exposed to sunlight must be coated with an ultraviolet inhibitor. The painting is allowed per the manufacturer's recommendations.
- c. The pipe and fittings must be manufactured in the USA, using domestic materials, by an ISO 9001 certified manufacturer.
 - 1) The pipe must be stored indoors after production at the manufacturing site until shipped from the factory.
 - 2) This pipe must carry the National Sanitation Foundation (NSF) seal of approval for potable water (PW) applications.
 - 3) Standard lengths of pipe size 6 inches and larger must be factory beveled each end. Exception: Plastic piping must come from the factory with square-cut plain ends.

- d. Heavy, corrosion-resistant coatings on metallic piping
 - 1) Type 6 pipe (galvanized steel pipe) must have a minimum G90 heavy corrosion-resistant coating applied to surfaces.
 - a) Type 5 (stainless steel) may be used instead of coated galvanized steel at the Contractor's option.
 - e. Piping used for chemical conduits/sleeves/chases
 - 1) Place chemical tubings which carry muriatic acid (pH control) and chlorine within Type 1 conduits/sleeves/chases.
 - a) Use only "sweep" (long ell) fittings to allow future replacement of the flexible chemical hoses
 - b) Air tubing and hoses for tubing supplying air to each pneumatic valve must be placed within Type 1 conduits/sleeves/ chases.
 - f. Underground Piping: Piping (to the uppermost pipe hemisphere) must be placed a minimum of 18-inches [455 mm] underground unless detailed otherwise.
 - 1) Exception: Refer to the local codes' Drawings and established freeze / frost-line elevations in cold climates. Frost-line invert elevations must be observed without exception.
3. Type 1 Piping:
- a. PVC Schedule 40 pipe must be manufactured from a Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell-Classification of 12454 per ASTM D1784.
 - b. The pipe and fittings must be manufactured in compliance with ASTM D1785 and D2665 (where applicable), consistently meeting or exceeding the Quality Assurance testing requirements of these standards regarding material, workmanship, burst pressure, flattening, and extrusion quality.
 - c. The Basis of Design: Pipe & fittings must be manufactured by Spears Manufacturing Company, 15853 Olden St., Sylmar, CA 91342, or (PO Box 9203, Sylmar, CA 91392); (818) 364-1611; www.spearsmfg.com or a pre-approved equal.
4. Type 2 Piping:
- a. PVC Schedule 80 pipe and fittings must be manufactured from a Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell-Classification of 12454 per ASTM D1784.
 - b. The pipe and fittings must be manufactured in compliance with ASTM D1785, consistently meeting or exceeding the Quality Assurance testing requirements of this standard regarding material, workmanship, burst pressure, flattening, and extrusion quality.
 - c. The Basis of Design: Pipe must be manufactured by Spears Manufacturing Company 15853 Olden St., Sylmar, CA 91342 or (PO Box 9203, Sylmar, CA 91392); (818) 364-1611; www.spearsmfg.com or a pre-approved equal.
5. Type 3 Piping:
- a. CPVC Schedule 80 pipe and fittings must be manufactured from a Type IV, Grade I Chlorinated Polyvinyl Chloride (CPVC) compound with a Cell-Classification of 23447 per ASTM D1784.

- b. The pipe and fittings must be manufactured in compliance with ASTM F441, consistently meeting the Quality Assurance test requirements of this standard regarding material, workmanship, burst pressure, flattening, and extrusion quality.
 - c. The Basis of Design: Pipe & fittings must be manufactured by Spears Manufacturing Company 15853 Olden St., Sylmar, CA 91342 or (PO Box 9203, Sylmar, CA 91392); (818) 364-1611; www.spearsmfg.com or a pre-approved equal.
6. Type 5 Piping:
- a. Schedule 10S, Grade 304 (or better) stainless steel piping.
 - b. The pipe and fittings must be manufactured in compliance with ASTM A312, consistently meeting or exceeding the Quality Assurance testing requirements of this standard regarding material, workmanship, burst pressure, flattening, and extrusion quality.
7. Type 7 Piping:
- a. PVC, Schedule 80, Clear pipe, and fittings must be manufactured from a Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell-Classification of 12454 per ASTM D1784.
 - b. The pipe must be manufactured in compliance with ASTM D1785, consistently meeting or exceeding the applicable Quality Assurance test requirements of this standard regarding material, workmanship, burst pressure, flattening, and extrusion quality.
 - c. The pipe must be manufactured in the USA by an ISO 9001 certified manufacturer. PVC Schedule 80 CLEAR pipe and fittings must be packaged immediately after its manufacture to prevent damage and be stored indoors at the manufacturing site until shipped from the factory.
 - d. Clear PVC piping and fittings have no UV inhibitors and must not be placed outdoors or exposed to sunlight or UV exposure.
 - e. The Basis of Design: Clear pipe & fittings must be manufactured by Spears Manufacturing Company 15853 Olden St., Sylmar, CA 91342 or (PO Box 9203, Sylmar, CA 91392); (818) 364-1611; www.spearsmfg.com or a pre-approved equal.

C. FITTINGS

1. Unless otherwise specified herein or listed on the Drawings, the fittings must be as follows:
 - a. Fittings must be of the same pipe schedule and rating as the pipe material specified.
 - b. Pump inlet/outlet piping fittings must be either:
 - 1) Type 3 to resist possible high-temperature deformation
 - 2) Type 5
 - 3) Type 6 coated for chemical resistance
 - 4) Type 6 pipes and fittings (if used) must have a minimum G90 heavy corrosion-resistant coating applied to surfaces before start-up. Such coating must be suitable for continuous exposure to mildly chlorinated water typical of pool water.
 - 5) Typical Type 1 or Type 2 piping or fittings may not connect to pumps due to potential high temperatures.

c. Threaded Fitting must be as follows:

- 1) When threaded pipe joints and fittings are used, fittings must be Type 2 minimum. Metal threaded joints must have sufficient threads and be assembled with Loctite "No More Leaks" pipe thread sealant (item #80726) per Loctite's installation instructions. Plastic threaded joints must utilize PTFE thread tape or thread sealant that is approved by the fitting manufacturer. No more than three pipe threads must be exposed after the joint is made uptight – or – the fitting with male threads has become extraordinarily tight and sealed completely. Female plastic pipe threads must only accept male plastic fittings. In male pipe threads of a metal pipe, a metal female fitting, or Special Reinforced (SR) plastic female fitting must be used. Female metal pipe threads may accept plastic or metal male pipe threads.
- 2) Type 1 through Type 4 piping connections must be socket welded or flange connections except where flanged connections are detailed.
- 3) Eccentric Reducers:: Unless This Engineer provides specific written direction, all eccentric reducers must be provided with the flat side up to prevent air-locks or trapped air within the piping.
- 4) Concentric Reducers: No concentric reducers are allowed on gravity flow piping, direct suction piping, or static piping.

d. Plastic-type fittings Types 1 through Type 3

- e. The Basis of Design: Fittings must be manufactured by Spears Manufacturing Company 15853 Olden St., Sylmar, CA 91342 or (PO Box 9203, Sylmar, CA 91392); (818) 364-1611; www.spearsmfg.com or a pre-approved equal.

D. FLANGES AND FLANGE HARDWARE

1. Pipe flanges must comply with the requirements specified herein. When flanged pipe joints are used, flanges must be standard ANSI geometry and rated as Class 150.
2. Flanges may be either welded slip-on flanges or "Vanstone" lap joint flanges except where one type is specified herein.
3. Manufacturer-accepted (subject to This Engineer's approval) synthetic non-degradable gaskets must be used at flange joints. VITON gasket materials must be considered as a minimum.
4. Bolts, washers, and nuts must be stainless steel, grade 316L minimum.
 - a. Flange hardware exposed to Seawater must be rated A286 Stainless Steel 2205 UNS S31803.
 - b. Flange hardware installed within remote locations must be provided with an appropriate epoxy coating to provide a potentially longer useful life.
5. Threaded fasteners must have Loctite #271 applied to bolt threads before tightening and torqued to a value sufficient to load the bolt to 40-60% of bolt yield strength.

E. FEATURE MANIFOLDS & ASSEMBLIES

1. Manifolds must be complete units and be Type 5 and incorporate the Drawing requirements to include:
 - a. The specified quantity of inlets and outlets
 - b. The specified branch pipe diameters

- c. The overall primary trunk diameter
- d. Only flanged connections
- e. Only Globe valves for proportional flow type control (unless otherwise indicated)
- 2. Supply manifold supports to support the specified weights, maintain the manifolds in position, and minimize any movement or vibration during the operation of the feature.
- 3. Piping manifolds, fittings, clamping devices, anchor bolts, connections to manifolds, nozzles, light fixture brackets, weir plates, and inlets in features must be made of Type 5 (Schedule 10S, stainless steel) piping.

F. ASSEMBLIES, FLEXIBLE CONNECTORS, JOINTS, AND SPECIAL FITTINGS

- 1. Rubber expansion joints: Fabricated, molded rubber units equipped with flanges and as noted below:
 - a. Hypalon rubber to resist mildly chlorinated water
 - b. Flanges with Hypalon enamel painted over the ductile iron portions
 - c. Molded reinforcement and steel rings and rods must assist in the PSI rating and inches of mercury pressure/force ratings.
 - 1) The target pressure rating must be 50 psi [344.7 kPa]
 - 2) The target vacuum rating must be 30-inches [760 mm] of mercury
 - a) Exception: Joint assemblies for pipe sizes greater than 24-inches [610 mm] can withstand a vacuum of 20-inches [510 mm] minimum.
 - d. Provide control rod assemblies with each flanged rubber expansion joint
 - 1) Control rod assemblies and hardware must be 316L
 - e. The Basis of Design: Model 502H as manufactured by Mercer Rubber Company, 350 Rabro Drive, Hauppauge, NY 11788, 631.582.1524, or a pre-approved equal.
- 2. Flexible Connectors: Provide fabricated, flexible connector units equipped with flanges, as noted below:
 - a. Refer to the Drawings for locations required
 - b. Stainless steel V-Loops technology to address pipe motion
 - 1) Incorporate stainless steel flexible bellows, double-braided piping with flanged end connectors, and rated for mounting in building spaces or direct-burial locations.
 - c. Must be capable accommodating up to 4-inches [100mm] movement in pipe sizes 1.5-inches [37mm] through 12-inches [305mm] at up to 160 PSIG [1103 Kpa].
 - d. Observe manufacturer requirements.
 - e. The Basis of Design: Model: Kinflex V-Loop as manufactured by Kinetics Noise Control, Inc., Dublin, Ohio, 1-877-457-2695; www.kineticsnoise.com

G. PIPING SIZE SCHEDULES

- 1. Refer to the schedules and sizes within the Drawings.

H. PVC CEMENT & PRIMERS

- 1. Apply purple primer on PVC surfaces before applying PVC cement

2. Thermoplastic solvent cement: Heavy Bodied, Medium Setting High-Strength, Industrial Duty for sizes through 12-inches [305 mm]; Extra-Heavy Bodied, Slow Setting Industrial Duty for sizes 14-inches [355 mm] and above.
 3. The Basis of Design: PVC cement & primers must be manufactured by Spears Manufacturing Company 15853 Olden St., Sylmar, CA 91342 or (PO Box 9203, Sylmar, CA 91392); (818) 364-1611; www.spearsmfg.com as noted below:
 - a. Listed for NSF Standard 61 for Potable Water
 - b. Primer for PVC: Spears Primer-70 Industrial Grade, Purple
 - 1) A clear primer is acceptable for connections made indoors.
 - 2) Primer for CPVC: Primer-70 Industrial Grade, Purple Clear primer is acceptable for connections made indoors.
 - c. Cement for PVC: Spears PVC-11 Gray for sizes through 12-inches [305 mm]
 - d. Cement for PVC: Spears PVC-19 White or Gray for sizes 14-inches [350 mm] through 30-inches [750 mm]
 - e. Cement for CPVC or PVC: Spears CPVC-24 Gray or Orange (for all sizes)
- I. PIPE HANGERS, HARDWARE, AND SUPPORTS
1. Pipe fasteners, hangers, and similar support systems requiring a structural interface or dependency on the Architect's building structure must be provided as a Complete Build Activity with Delegated Engineering Services submittals.
 - a. Refer to 1.08 SUBMITTALS
 - b. Refer to 1.09 QUALITY CONTROL
 - c. The project's structural engineer of record must approve Fasteners, hangers, and supports anchored to the building structure and must be sized per the pipe and hanger manufacturers' requirements related to the specific pipe size, spacing associated loads.
 2. The work-scope covered under this section consists of furnishing all necessary materials and equipment to entirely execute the pipe hanger and supports, as described in this specification.
 3. Steel pipe hangers and supports must have the manufacturer's name, part number, and applicable size stamped on the part itself for identification.
 4. Hangers and supports must be designed and manufactured in conformance with MSS SP 58.
 - a. The materials specified for the pipe support methods indicated in the Drawings are SST 304 (or better) or plastic. If only steel hangers or supports are available, they must be surface-coated (after priming) to avoid rust and corrosion. However, all threaded components of the hanger must be stainless steel 304 or better.
 - b. Exception:
 - 1) Hangers and supports in chemical rooms must be plastic, fiberglass, or other non-metallic materials without exception.
 - 2) Hangers & supports within the collector/surge tank and gutters must be plastic, fiberglass, or other non-metallic materials (submit for approval).

- a) V-Bottom clevis hanger with plastic/fiberglass equivalents of 18-gauge continuous support channel, B-Line B3106 and B3106V, to form a continuous support system for plastic pipe or flexible tubing.
 - c. Primer and top coatings for steel hanger and support components must be from the same manufacturer. Pre-approved manufacturers and products include:
 - 1) Rust-Oleum: 7780 Clean Metal Primer or 7769 Rusty Metal Primer with compatible Rust-Oleum Top Coat
 - 2) MAB Paint Company: Rust-O-Lastic Zinc Chromate Primer with Rust-O-Lastic Finish Coating
 - 3) Fuller - O'Brien Paints & Coatings: Blox Rust Alkyd Metal Primer (verify for the type of metal) with Versaflex Heavy Duty Alkyd Gloss Enamel
 - d. Stainless steel materials are not to be painted or coated except as noted in the Drawings.
5. The minimum support size must be 1-inch [25 mm] x 2-inches [50 mm] coated galvanized steel with the appropriate pipe straps for support.
6. The Basis of Design:
- a. Manufacturer: Subject to compliance with these specifications, pipe hangers and support systems must be manufactured by Cooper B-Line, Inc. or an engineer-approved equal. Cooper Industries, Inc.; 509 West Monroe Street Highland, IL 62249, USA; 800.851.7415; www.cooperindustries.com

J. PIPE LABELING

- 1. Compliant with Brady B-946 custom legend, self-sticking markers, and arrows or Engineer-approved equal
- 2. The Basis of Design: Brady Corporation, Phone: 800-643-8766 (www.bradycorp.com) or Graphic Products, Inc., Phone: 888.326.9244 <http://www.duralabel.com/free-gifts/thankyou-pipemarking.php#ixzz2TsmLNeLx>

2.07 FINISHES & COPING

A. GENERAL

- 1. Non-slip tile must mean impervious, non-glazed manufacturer-classified & labeled as "non-slip," "non-skid," or "slip-resistant" to be suitable when installed on all horizontal surfaces and sloped surfaces.
 - a. Textured, impervious, non-slip copings, decks, & tiles must have a dynamic coefficient of friction (DCOF) of less than or equivalent to 0.42 (per ASTM C1028) in wet conditions and be branded by the manufacturer as having a "non-slip" or "slip-resistant" surface and can be located in a sloped condition.
 - b. The slip-resistant finish must be incorporated from the original manufacturer, "after-market" slip-resistant applications onto surfaces or tiles are not allowed.
- 2. Tile sizes: Refer to the Drawings for specific tile sizes required
- 3. Pools' interior finishes must be a white or light color with a smooth and easily cleanable surface.

- a. Caution: Interior color finishes other than "White" require specific approval from the local Health Dept (for pools).

B. TILES

1. The Basis of Design: Dal-Tile

- a. Tiles must be "frost-proof" capable of withstanding the expected weather and climatic conditions at the project's locale.
- b. Decorative tile: 2-inches by 2-inches [50 mm x 50 mm] porcelain ceramic manufacturer-rated as non-slip.
 - 1) Exception: Refer to the Drawings for specific sizes of tiles and the extent of the tiles.
- c. All protruding corner edges must incorporate at least one bullnose trim tile.
- d. Glass tiles are not permitted unless approved explicitly by This Engineer.
- e. Tiles provided with back-mounted mesh and coatings that might prevent a full bond to the back-of-tiles must be rejected without exception.
- f. A minimum 6-inch [152 mm] tile line must be installed at the waterline but must not exceed 12-inches [305 mm] in height if a dark color is used. Gutter-type pools may substitute 2-inches [51 mm] tile along the gutter lip's pool wall edge.

2. Wall, floor, and marker tiles

- a. Tiles at the underwater expansion joint: multiple white 2-inches by 2-inches [50 mm x 50 mm] porcelain, non-slip tiles.
 - 1) Exception: Refer to the Drawings for specific sizes of tiles
- b. Zero-entry Tiles, stone finishes, or pavers are detailed and must have impervious, textured, non-slip/slip-resistant characteristics & qualities.
- c. Lettering for marker tiles: Contrasting color, 4-inches [101 mm] high.
- d. Vertical-Placed Marker Tiles & Wall Tiles: 6-inches [152 mm] high, glazed, smooth surface.
- e. Horizontal-Located and Sloped Copings and Tiles: Manufacturer-classified as non-glazed, textured, impervious, and slip-resistant. The manufacturer must pre-designate all manufactured surface products that are especially suitable for sloped walking surfaces in wet areas.
 - 1) Where the gutter is used as the top step, the tile on the gutter for the width of the steps must be slip-resistant & impervious.
 - 2) The impervious, slip-resistant, textured finish must be incorporated from the original manufacturer, "after-market" slip-resistant applications onto the tiles are prohibited.
- f. An approved universal NO DIVING symbol tile (red) may be substituted for the spelled "NO DIVING" tiles.

3. Step edge, gutter lip trim, bench edge, & racing lane tiles

- a. Step edge tiles must be 2-inches x 2-inches [50 mm x 50mm] (or pre-approved 1-inch x 1-inch [25 mm x 25mm]) dual tiles, as noted in the finish schedule in a very dark contrasting color (use Dal-Tile Cobalt Blue for pricing purposes).

- 1) The horizontal, slip-resistant tiles on the step/gutter/bench edges must cover a minimum of 2-inches [50 mm]. Refer to the Drawings.
- 2) The vertical tiles at the step/bench edges must cover a minimum of 2-inches [50 mm]. Refer to the Drawings.
- b. Step/gutter/bench edge horizontal nosing tiles must consist of impervious, slip-resistant, textured tiles that are a Munsell color value from "zero" to "four" and contrast to the interior of the pool (and gutter edge) surfaces.
- c. Provide unique shaped tile and bullnose tiles as detailed in the Drawings.
 - 1) In all cases where two tiles are installed in a protruding, perpendicular condition resulting in an approximate 90-deg (or similar corner) edges being evident, the installer must provide at least one of those tiles having a bullnose trim.
 - 2) The tile edges (using bullnose trim tiles) located at gutter lips and step edges are typical details and examples applicable and indicate similar tiled conditions. All horizontal-located and sloped tiles must be rated by its manufacturer as impervious, slip-resistant, and textured.
- d. Vinyl-liner and fiberglass pools may use other material for the step edge marking, provided the material is permanent, permanently secured, dark in color, nonfading, and slip-resistant.
- e. Pools that are not intended for officially sanctioned competition may have 2 to 6-inches (51 to 152 mm) wide 18-inches by 18-inches (457 mm by 457 mm) targets (+) installed on the pool wall. Refer to the Drawings for the specific detailed dimensions, accompanying floating rope lines that do not obstruct steps or ladders.

C. COPING

1. Coping must be one of the following materials
 - a. Travertine
 - b. Flagstone
 - c. Slate
 - d. Bluestone
 - e. Limestone
 - f. Sandstone
 - g. Granite
 - h. Coral stone (or shell stone)
2. Refer to the Landscape Architect's drawings for finish selections
3. Copings must be rated as "impervious, textured, non-slip" or "impervious, textured, slip-resistant," as noted above for horizontal and sloped surfaces.

D. INTERIOR QUARTZ-PLASTER FINISH

1. Interior basin surfacing must be a combination of quartz-plaster (and tiles) as detailed.
2. Pool floors & walls must be white or light pastel in color and must have the characteristic of reflecting rather than absorbing light. The interior finish coating floors and walls must comprise a nonpigmented white cementitious binder component and a sand/aggregate component.

- a. The finish coating must have a dry lightness level (CIE L value) of 80.0 or greater and a wet luminous reflectance value (CIE Y value) of 50.0 or greater, as determined by test results provided by the manufacturer, utilizing testing methodology from American Standard ASTM D4086, ASTM E1477, ASTM E1347.
 3. Quartz Plaster: "KrystalKrete" by CL Industries, Inc.; Orlando, FL. 1-800-333-2860; www.clindustries.com
 - a. Before installing/providing the KrystalKrete, the mandatory use of a scratch-coat and manufacturer-approved bonding agent must be with PermaKote by CL Industries, Inc., Orlando, FL. 1-800-333-2860;
 - b. No admixtures are permitted without the written approval of This Engineer.
 - c. Color: "KRYSTAL BLUE" to be used for pricing purposes.
- E. DECKING & WET DECK
 1. Refer to the Architect and Landscape Architect; however, the following are minimum code requirements to be incorporated into the Architect's & Landscape Architect's designs:
 2. Concrete, Unit-Pavers, or similar structurally-rigid decking materials incorporating concrete, impervious, slip-resistant surfaces, and specialty tile wet area surfacing systems noted herein:
 - a. Caution – There are Code-required Issues to be observed in decking specifications and its execution:
 3. EVA-rubber copolymer tile wet area surfacing system
 - a. An NSF-Standard 50 approval & listing is required.
 - b. Material: EVA-rubber copolymer tile wet area surfacing system is a factory-molded surface composed of EVAtrax™, an ethyl vinyl acetate copolymer. Note that the type of attraction determines the required tile thickness.
 - 1) Depending on ASTM F1292 requirements for critical fall-height 6' select tile thickness from optional thicknesses 1 1/4".
 - 2) Refer to the Drawings for the specified thickness. Weight:
 - a) 3/8-inch standard = 2 pounds [0.9kg]
 - b) 7/8 inch = 4.4 pounds [2kg]
 - 3) Color & Patterns: Refer to the Drawings
 - 4) The Basis of Design: Life Floor, 2010 E Hennepin Ave. #8, Building 8 Suite 206, Minneapolis, MN 55413, Phone: (612) 567-2813. E-mail: solutions@lifefloor.com; www.lifefloor.com
- F. GRATES – DECK AND TRENCH
 1. System Description
 - a. Allowable loads on stainless steel grating must be 1,500 pounds per square feet [7,323.64 kG per square m].
 - b. Grating must be linear, with grating bars running the length of the trench.
 - c. Trench channel and pool deck grating must be locked down flush with adjacent finish decking. Provide grating with concealed locks and be independently removable.

- d. Plastic deck drain units must contain UV inhibitors, have a removable grate top, utilize stainless steel grade 316L hardware, and adapt to underground piping system connections.
 - e. Stone Grating: Pool grate material must be stone (reinforced) of at least 30% recycled materials. The material is a 95% agglomeration of natural stone substrates & mineral oxides formed under a high-tech vacuum & compression process. It is a proprietary formulated structural polymer hybrid system of a complex blend.
2. Stainless Steel Grating
- a. The Basis of Design: SSS Clean Tread™ Model KD98 MM Way, sales@kadeeindustries.com; Kadee Industries, Inc., Walton Hills, OH 44146 Phone: 800.321.3827
 - b. Materials
 - 1) Provide SSS Clean Tread™ Model KD98 Entrance Floor Grilles and Frames
 - 2) Grille thickness must be 1-1/8 inch with a minimum Coefficient of Friction of 0.6 as measured by the James Machine defined in ASTM D2047 using Standard Neolite in dry and wet testing.
 - 3) Tread Material must be manufactured from Type 316L stainless steel .071-inch x .177-inch surface wires spaced with a .125-inch slot opening, and resistance welded to .070 x 1.0-inch Type 316L stainless steel support rods spaced 1 inch on center.
 - 4) Hidden Lockdowns [conventional construction]: Entrance Floor Grilles must include hidden locking devices manufactured from formed Type 316L stainless steel saddle clip slotted to receive a spring clip with ASTM A193 Grade B8 18-8 stainless steel machine screw.
 - 5) Hidden Lockdowns must be spaced no more than 2-ft [610 mm] on center.
 - 6) Fasteners, accessories, and other materials are specified for complete installation per the manufacturer's installation instructions and meeting performance requirements.
 - 7) Drainage Pit Frames:
 - a) Provide welded frames fabricated from 1.25-inch x 1.25-inch x 0.125-inch thick Type 304 (or better) stainless steel angle with splice plates as required, complete with grouting strap anchors permanently recessed application.
 - b) Provide welded intermediate framing supports manufactured from 1-1/2-inch x 1-1/2-inch x 3/16-inch Type 304 (or better) stainless steel angle spaced no greater than 3-Feet on center with a uniform floor load of 300 lb./square feet and no more than 2-Feet on center with a consistent floor load of 500 lb./square ft.
 - c. Fabrication
 - 1) Comply with NAAMM'S "Metals Finishes Manual for Architectural and Metal Products."
 - a) Tread Material: Stainless-Steel: Polished-Finish No 4 Fabricate pool deck grating assemblies as detailed.
 - b) Stainless Steel Frames: Stainless Steel Mill Finish No. 2
 - 2) Tread Surfaces: Serrated.

- 3) Provide related parts, devices, trench liner, anchors, and other items necessary for water-tight installations.
 - 4) Fabricate splices, corner units, corner fittings, intersections, and end closures.
 - 5) Factory miter and weld joints.
 - 6) Provide components in a single size where possible; minimize site splicing.
 - 7) Provide maximum size recommended by the manufacturer for units intended for removal and cleaning. If joints are necessary for the grating, spaced symmetrically, away from typical traffic flow patterns.
 - 8) Provide a minimum number of pieces possible for frames that exceed the maximum length. Provide frames with hairline joints, equally spaced, intact with corner pin, splice plates, and installation anchors.
 - 9) Shop fabricate frame as an assembled unit for installation.
3. Plastic deck drainage & grating
- a. The Basis of Design:
 - 1) CAP-SHURE Deck Drain System as manufactured by Daldorado LLC. Ph: (888) 509-8128. No known equal.
 - b. The deck drain must be 4-inches [100 mm] wide, must have a 4-inches [100 mm] inside depth, and be formed of extruded PVC 0.2-inches [5mm] thick in lengths of 10-feet [3.05 m] in straight or custom radii down to a 6-feet [1.83 m] inside diameter.
 - 1) Each deck drain section must be provided with EPDM joiners that also perform as expansion joints.
 - 2) The deck drain base must have 5/8" pre-drilled holes at 18-inches [457 mm] OC. These holes are provided for the use of threaded rods with lock nuts for ease of leveling. Size, location, and the number of stormwater (sanitary sewer) drain outlets to be determined by local rain/sewer water requirements.
 - 3) The deck drain must be strength tested for light vehicle traffic. Color: gray only.
 - c. The deck drain grating must be formed of molded PVC sections, certified NSF/ANSI 50, modular, interlocking sections, and UV stabilized.
 - 1) The top section must have a raised herringbone design and be certified to IBC Classification C for Wet-Barefoot inclining platform (ramp) test for swimming pool surroundings and communal shower rooms.
 - 2) Grating must be 0.47-inches [12 mm] wide and an outside depth of .83-inches [21 mm] with a middle depth of 1.1-inches [27.7 mm] for load strength requirements.
 - 3) The grating must be certified under ANSI/AS3996 class A for covers and grates with a load exceeding 10kN (2,248lb).
 - 4) The space between the bars must not exceed 0.315" (8mm) to comply with IBC child finger/toe entrapment guidelines.
 - 5) The grating surface bars gap provides at least 40% open space per foot for unrestricted water capture.
 - 6) Color to be selected by the Architect/Owner. Available in colors white, bone, or gray.
 - d. Dropouts drain boxes:

- 1) ~ 12"x12"x12" pre-manufactured, corrosive resistant, non-conductive, non-magnetic.
- 2) Deck Drain flow inlets to be provided on the box's sides to suit project requirements with bottom or side exit drain for connection to stormwater (sanitary sewer) system. Color: gray only.
- 3) Each drain box to be supplied with a grate. (Each drain box to be supplied with a strainer for more accessible cleanout.)
- e. 12" x 12" grating:
 - 1) Grating must be formed of molded PVC, certified NSF/ANSI 50, UV stabilized. The top section has a raised herringbone design with raised herringbone design and certified to IBC Classification C for Wet-Barefoot inclining platform (ramp) test for swimming pool surroundings.
 - 2) Grating must be 0.47-inches [12 mm] wide and an outside depth of 1.0-inches [25.4 mm] with a middle depth of 1.83-inches [46.6 mm] for load strength requirements.
 - 3) The grating must be certified under ANSI/AS3996 class A for covers and grates with a load exceeding 10kN (2,248lb).
 - 4) The space between the bars must not exceed 0.315-inches [8 mm] to comply with the IBC child finger/toe entrapment guidelines.
 - 5) Grate color to be selected by the Architect/Owner.
 - 6) Colors available in white, bone, and gray. The grating must have a minimum 10-year manufacturer's warranty.
 - 7) Pool deck channel-grating system model CapSHURE
4. Trench channel and trench-deck grating
 - a. The trench channel at the zero-depth and rim-flow perimeter overflow systems must be continuous and incorporate acrylic/fiberglass custom channels.
 - b. The grating must be formed of molded PVC sections, certified NSF/ANSI 50, modular, interlocking pieces, and UV stabilized.
 - 1) The top section must have a raised herringbone design and be certified to IBC Classification C for Wet-Barefoot inclining platform (ramp) test for swimming pool surroundings and communal shower rooms.
 - 2) Grating must be 0.47-inches [12 mm] wide and an outside depth of 1.0-inches [25.4 mm] with a middle depth of 1.83-inches [46.6 mm] for load strength requirements.
 - 3) The grating must be certified under ANSI/AS3996 class A for covers and grates with a load exceeding 10kN [2,248 lb.].
 - 4) The space between the bars must not exceed 0.315-inches [8 mm] to comply with the IBC child finger/toe entrapment guidelines. The grating surface bars must run parallel to the pool wall and with the gap providing at least 40% open space per foot for unrestricted water flow.
 - 5) Fasteners must be SS-316 and be provided by the manufacturer. The grating's width must allow the touchpad's insertion holding brackets between the grating and the gutter lip.

- 6) All inside and outside corners and custom radii sections under 3-feet inside diameter must be custom fabricated and strengthened by the manufacturer.
 - 7) Grate width to be 10-inches (12-inches, 14-inches, & 16-inches) and supported each side by the pool gutter lip no less than 1.5-inches [37 mm] in width.
 - 8) Grate color to be selected by the Landscape Architect/Owner.
 - a) Colors available in white, bone, and gray.
 - 9) The grating must have a minimum 10-year manufacturer's warranty.
 - 10) Basis of Design:
 - a) Grating must be manufactured by Daldorado LLC. Ph: (888) 509-8128, 4327 Arnold Ave, Naples, FL 34104; www.daldorado.com
 - b) No known equal.
 - c) Critical: Perpendicular type grating is not permissible
5. Stone Grating:
- a. The Basis of Design:
 - 1) The pool stone grating system by Jonite Stone with lockable units
 - 2) The slip-resistant surface in the model and color indicated in the Drawings
 - 3) Materials: Reinforced, 95% natural aggregates, and hybrid polymers
 - 4) ADA compliant
 - 5) The Basis of Design:
 - a) Jonite Private Limited; 5 Upper Aljunied Link Quartz Industrial Building #01-01; Singapore 367903; Phone: +65 6383-3788; www.jonite.com
 - b) Jonite USA; 1275 Glenlivet Drive, Suite 100 Allentown, PA 18106; +1.484.224.2972; info@jonite.com

2.08 BASIN & SITE EQUIPMENT

A. GENERAL

1. Hardware (screws, nuts, and similar connection devices must be Stainless Steel (Grade 304 (or better))).
 - a. If these hardware items are visible to guests, then the minimum stainless-steel grade is 316L.
2. Contact This Engineer if there are questions concerning the determination of the basin type and applicability of design standards.
3. Without exception, all metallic components must be provided with a UL-Listed ground lug capable of accommodating #8 solid copper bonding/grounding insulated conductor/wire. If the metallic component is not equipped with such a UL-Listed lug, the Contractor must provide it.
4. The quantities indicated in the Drawings are for the Contractor's general information; however, it is the Contractor's responsibility to verify the actual quantities required.

B. BASIN DRAINS, RELIEFS, SUMPS, & FLOOR EQUIPMENT ASSEMBLIES

1. Anti-Vortex Plates
 - a. Anti-vortex plates must be used to stabilize pool pump suction piping in surge-tank (balance-tank; surge weir gutter) to prevent water vortex.

- 1) The anti-vortex plate must be fabricated from ½" Type 1 PVC board. The plate must be designed to reduce velocity from 6-fps to 1.5-fps maximum.
 - 2) The anti-vortex plate must include the following hardware; 4-316-SS nuts, 4-316-SS threaded rods, and 8-316-SS washers as supplied by the manufacturer.
 - b. Anti-vortex plates and hardware as manufactured and supplied by Daldorado LLC. Ph: (888) 509-8128, 4327 Arnold Ave, Naples, FL 34104; www.daldorado.com or approved equal.
2. Floor Drains & Sumps
- a. For basins/ pools that are authorized for human swimming and recreation activities, the following must apply:
 - 1) Main suction outlets – SOFA (main drain sumps, frames, and grates), sizes as indicated on the drawings, with "25-Year Service Life" under VGB, as manufactured and supplied by Daldorado LLC.
 - 2) Sumps/drains must be a fiberglass pre-manufactured SOFA (Suction Outlet Fitting Assembly) corrosion-resistant, non-conductive, non-magnetic, high strength 8oz fiberglass matt with marine grade white gel coat.
 - a) SOFA must have a 2.6-inches [65 mm] FRP angle around the outside perimeter 5-inches below the top rim and a 2-inches x 2-inches FRP T-bar around the perimeter for added strength. The sump/drain must be supplied complete with frame and grate.
 - b) The complete unit must have been tested and labeled by the manufacturer in compliance with APSP-16 2011, Suction-Outlet Fitting Assemblies for Use in Swimming Pools.
 - 3) All sumps/drains and grates/covers to be USPC® certified.
 - 4) Sizes as shown on the drawings. Available main suction outlet sizes (sizes in inches):
 - a) (24x24x30, 18x36x24, 18x36x28, 18x36x34, 18x54x24, 18,54,28, 18x54x34)
 - b. For basins that are designed only for non-human use, decorative or display architectural fountains, and non-swimming water features, the following must apply:
 - 1) Drains and anti-vortex covers must be pre-manufactured units. The integral anti-vortex cover must allow the flush insertion of tiles as indicated on the Drawings (to assist in disguising the drain body).
 - 2) Suction & inlet bodies, strainers, anti-vortex plates, securements, and fasteners must be fabricated as specified and outfitted for integral tile installations, flow regulator assemblies, and bonding/grounding-to-earth lugs for metallic components. Refer questions to This Engineer as needed.
 - 3) Piping connections must be supplied with tapered, imperial threads for sizes 2-inches [50 mm] through 8-inches [12 mm through 200 mm].
 - 4) The Basis of Design:
 - a) DALMAX units by as manufactured and supplied by Daldorado LLC. Ph: (888) 509-8128, 4327 Arnold Ave, Naples, FL 34104; www.daldorado.com or pre-approved equal.

- c. In the case of a stainless-steel pool, floor drains must be specified, supplied, and installed by the basin manufacturer. Drains must be designed and fabricated to facilitate monolithic concrete slab or block-out type installations and concrete bonding. Drains must be equipped with bonding/grounding UL-Listed grounding lugs or approved holes for connecting bonding/grounding conductors/wiring. All sumps must be in conformance with ANSI/APSP-16 2011.

3. Floor inlet equipment

- a. Floor-located water inlet fittings must be white cycolac, nominal 4-inches [100 mm] square with the water-flow-adjustability feature.
- b. Inlet: Adjustable-flow type.
- c. The adjustable inlet fitting must be provided with 1.5-inches [40 mm] socket x 2-Inch [50 mm] MIP connections.
- d. The Basis of Design: Model Hayward SP1425S, Adjustable Floor Inlet Concrete Pool Fitting by Hayward Pool Products, Inc.; One Hayward Industrial Drive, Clemmons, NC 27102, (908) 355-7995; www.hayward-pool.com.

4. Hydrostatic Relief Equipment

- a. Drain Sump-Located Relief Fittings: One relief fitting must be factory installed in each drain sump; include a collection tube.
 - 1) Material: White cycolac or white ABS material can be flushed mounted in each basin's drain sumps.
 - 2) Primed spring-loaded, leak-proof, and have a self-cleaning O-ring seal.
 - 3) The fitting must be provided with a 1.5-inches [40 mm] x 2-inches [50 mm] MIP connection. Include a collection tube as recommended by the manufacturer.
 - 4) The Basis of Design:
 - a) Models #SP-1056 & #SP-1055, Hydrostatic relief fittings must be by Hayward Pool Products, Inc.; One Hayward Industrial Drive, Clemmons, NC 27102, (908) 355-7995; www.hayward-pool.com.
 - 5) In a stainless-steel pool, the basin manufacturer may specify an alternate hydrostatic relief fitting within each drain sump.
- b. Floor-Located Hydrostatic Relief Fittings:
 - 1) These pool plugs must be shipped with no pool plaster in the lead weight cap.
 - 2) The relief fitting must be "The Pool Plug" by Swimming Pool Specialties, Inc.; 860 Pennsylvania Ave, Hagerstown, MD 21742-(301-733-7750).

C. BEAM PERIMETER & WALL EQUIPMENT ASSEMBLIES

- 1. Gutter Mounted Elements: Must be designed and fabricated to withstand forces specified by the accessory manufacturer and recognized swimming authority in addition to those services' conditions specified by governing code officials. Exposed steel must be polished stainless steel. All components must be designed to be flush, and there must be no protrusions of any kind that could potentially produce a tripping hazard
- 2. Hydromassage fittings
 - a. In the case of a stainless-steel pool, hydromassage fittings must be specified, supplied, and installed by the basin manufacturer.

- b. Therapy fittings must combine wall and jet fittings with integral flow-through connections for air and water supply lines.
- 3. Beam perimeter gutter fittings
 - a. Gutter drain fittings (body and grate) must be white cyclolac, nominal 2.75-inches x 4.5-inches [70 mm x 115 mm] with 4-square inches [2580 square mm] open area.
 - b. Fasteners: Size must be 2-inches [50 mm] female NPT plus 2-inches [50 mm] PVC Socket Connection. The gutter grate must be secured to the gutter body via stainless steel Grade 304 (or better) screws.
 - 1) Under no circumstances must a gutter grate be installed without a pre-manufactured gutter body.
 - 2) A rigid PVC pipe attached to the gutter body is a mandatory requirement.
 - c. Provide one gutter fitting to serve as an air-vent and located at a higher elevation for the gutter piping system.
 - d. The Basis of Design: Model #SP-1019 by Hayward Pool Products, Inc.; 900 Fairmount Avenue; Elizabeth, NJ 07207 (201-351-5400); www.hayward-pool.com and supplied per the Drawings.
- 4. Beam perimeter skimmer assemblies
 - a. Wall-mounted perimeter skimmers must be NSF-approved, ABS molded body with 10-inches [250 mm] diameter cover, an 8-inch [203 mm] full hinged weir with an automatic level adjustment of 4.5-inches [115 mm].
 - b. The skimmer must be provided with a thermoplastic strainer with 160 cu. inches [2620 cc] capacity, rated at 75 GPM [284 L/min].
 - c. The minimum flow is 30 GPM [114 L/min], and the maximum flow is 75 gpm [284 l/min] per each skimmer served by a minimum of 2.50-inches [65 mm] connection pipe.
 - d. Provide the VGB certified/listed equalizer fittings and approved grate assemblies to serve each direct-suction skimmer body per the Drawings and Equipment Schedule.
 - e. The skimmer units must be supplied with NSF-listed "spring-loaded" equalizer assembly mechanisms (or equivalent as provided by the manufacturer). Each skimmer body must have two – 2.5-inches [65 mm] diameter piping connections.
 - f. Each skimmer must have two - VGB certified, NSF approved, CPSC listed equalizer fittings approved as a submerged suction outlet and designed to be used as a skimmer's equalizer suction fitting for both floor and wall with a minimum open area of 13.80 square inches, and a Flow Rate of 44 to 49 gpm (rated for floor or wall installation. The 6" diameter grate must be removable for winterizing.
 - 1) Wading pool equalizer fittings must be connected to the floor located VGB sumps/grates.
 - g. The Basis of Design:
 - 1) Skimmer: Model # 540-6400 by Waterway Plastics, 2200 East Sturgis Road, Oxnard, California 93030, 805-981-0262, www.waterwayplastics.com
 - 2) Skimmer Equalizer Submerged suction outlets: Model 34-222 with 2-inches [50 mm] socket connection; Recreonics, 4200 Schmitt Avenue, Louisville, KY 40213, (800) 428-3254; www.recreonics.com

5. Wall inlet assemblies

- a. Wall-mounted water inlet fittings must be white cycolac, frame with 1.5-inches (socket x threaded FIP); when combined with a MIP threaded insert, provides a complete unit with adjustability features.
- b. The adjustable inlet fitting must be provided with a 1.5-inches [40 mm] PVC socket & threaded connections.
- c. The Basis of Design: Waterway Models # 215-9150 with insert # 400-1410D (White; 0.75-inch [18 mm]); Waterway Plastics, 2200 East Sturgis Road, Oxnard, California 93030, 805-981-0262, www.waterwayplastics.com

6. Wall static fittings

- a. Wall-mounted water static insert fittings must be white cycolac, nominal 2-inches [50 mm] diameter.
- b. The fitting must be provided with a 1.5-inches [40 mm] female socket and 2-inches [50 mm] male NPT connections.
- c. The Basis of Design: Wall Fitting Body - Model #34-009 and Safety Grate Insert Grate Model 34-013 by; Recreonics, 4200 Schmitt Avenue, Louisville, KY 40213, (800) 428-3254; www.recreonics.com

7. Hydrotherapy jet assemblies

- a. Hydrotherapy fittings must be white ABS and rated for 15 GPM [60 L/min] of water flow at a total dynamic head not exceeding 42-feet [12 m] total dynamic head.
- b. Therapy fittings must combine wall and jet fittings with integral flow-through connections for air and water supply lines.
 - 1) Piping systems for spa therapy assemblies must be independent of recirculation filtration and heating systems.
- c. The Basis of Design: Models (indicated below) Waterway Plastics, 2200 East Sturgis Road, Oxnard, California 93030, 805-981-0262, www.waterwayplastics.com and include:
 - 1) Therapy fittings: Model #210-7810
 - 2) Nozzles: Model #217-6620
 - 3) Wall fitting: Model #212-7600G & 215-6660

D. RAIL GOODS

1. General:

- a. Rails (& ladders) must be provided as a fabricated 1.50-inches [40 mm] x 0.120-inch [3 mm] O. D. (wall thickness) ASTM-A-554 grade 316L-stainless steel rail. The finished surfaces must be polished number 6-finish. Grab rail and grab rail anchor sizes must be coordinated to guarantee compatibility.
- b. Rails (handrails, grab rails, and ladders) used for entrance and exiting the pool and spa must be a minimum of 28-inches [711 mm] and a maximum of 40-inches [1016 mm] above the wet deck; however, refer to the Drawings for the specified height for this project.
 - 1) Locate the handrails to allow maximum accessibility to the steps

- c. Metallic components must be passivated, in compliance with ASTM A967-99, incorporating organic acid passivation techniques for maximum corrosion resistance. Following passivation, the metallic components must be electropolished to afford uniformity of surface finish.
 - d. Welds must be TIG type and be applied using ASTM-A-554 grade 316L series welding rod.
 - e. Bonding screws: Provide bonding screws (18-8 stainless steel). The minimum size of the bonding screws must be 0.24-inch [6 mm] in diameter.
 - 1) A bonding/grounding screw & UL-Listed grounding-lug must be provided on the lower portion of the anchor. The bonding screw must be Type 316L-stainless steel.
2. Deck Anchors:
- a. Grab Rail Anchors: Grab rails penetrating any PVC membrane must be anchored with PVC anchors mounted in concrete. Anchors must be designed and fabricated to withstand required loads and facilitate simple removal and replacement of the grab rail without damage or part replacement. Grab rail and grab rail anchor sizes must be coordinated to guarantee compatibility.
 - b. The anchor must be the standard cataloged product of a company regularly engaged in pool deck equipment manufacture.
 - c. The compression anchor must support a 1.50-inches [40 mm] O. D. stainless steel rail, providing circumferential support. The stainless-steel retainer ring must apply equal pressure around the rail's circumference – offering support in every conceivable direction of force, preventing rail damage and deformation. Wedges or anchor systems incorporating dissimilar metallic materials must not be allowed.
 - d. The anchor body and cover must be fabricated from high-quality copolymers. The anchor cover must incorporate four (4) countersunk holes to accommodate a three-point spanner wrench.
 - e. The anchor body must incorporate an anti-rotation fin. The fin must be in the uppermost part of the anchor body and help prevent the anchor from spinning in a concrete deck. The fin must be an integral component of the anchor body.
 - f. The anchor must be 6.25-inches [158 mm] high and must be 1.5-inches [40 mm] in diameter. Close tolerance dimensions must help achieve a secure fit for 1.5-inches [40 mm] O. D. railing.
 - g. Provide a stainless-steel compression ring. The ring must be designed to make sufficient contact with the 1.5-inches [40 mm] O. D. rail that the anchor is to secure. The compression ring must not deform the rail in any manner.
 - h. The anchor must have a flush mount design such that an escutcheon plate is not required.
 - i. An anchor spanner wrench must be supplied. It must be fabricated of stainless steel and must incorporate three hardened roll pins for cover contact and tightening.
 - j. Provide an anchor lid to place into the deck anchor when the rails are removed.
 - k. The Basis of Design: Model #: COM-1.50-6 inch supplied by Inter-Fab Commercial Aquatics, 3050 S. Alvernon Way, Tucson, AZ 85713; 520.790.7040;
www.ICAaquatics.com
3. Ladders

- a. Ladders must be fabricated of stainless steel (corrosion resistant) and must have slip-resistant, stainless steel tread steps. Cross braces are mandatory and must be attached to vertical ladder rails using stainless-steel split tees and stainless-steel hardware. The centerline distance between the vertical uprights of the ladder rails must be as dimensioned in the Drawings, allowing for a 3-inches [75 mm] minimum clearance between the pool wall and the back of the ladder tread.
- b. The ladder rails must have cross braces. Two (2) molded rubber bumpers must be provided, one for each ladder rail. The ladder rails and their gripping surface must comply with Accessibility Guidelines.
- c. Each ladder tread is configured for 20-inches on the center [508 mm], having 83.25 square inches [53709 mm²] of surface area, and must be equipped with a step reference locator. The tread top must have a slip-resistant top surface and must incorporate nut inserts, eliminating the need for exterior nuts and sharp surfaces.
- d. The ladder must be capable of being supported by two (2) 6.25-inches [156 mm] deep escutcheons-less copolymer compression anchors.
- e. The Basis of Design: Ladder assemblies must be by Inter-Fab Commercial Aquatics, 3050 S. Alvernon Way, Tucson, AZ 85713; 520.790.7040; www.ICAAquatics.com

4. Hand Rails

- a. The stair rail must be of multiple custom-bend designs. The stair rail must match the geometry and dimensions indicated in the Drawings and must include an 18-inches [540 mm] horizontal flat portion of the rail for user stability.
- b. The rail height must comply with Accessibility Guidelines
- c. If the rail length exceeds 8-feet [2.43 m], provide an additional vertical support post. If the rails are intended for handicapped ramps, then vertical support posts must be equally spaced and not exceed a maximum spacing of 7.5-feet [2.28 m] and must comply with Accessibility Guidelines.
- d. Two (2) 6.25-inches [156 mm] deep escutcheons-less Copolymer compression anchors must support the stair rail.
- e. The Basis of Design: Items must be by Inter-Fab Commercial Aquatics, 3050 S. Alvernon Way, Tucson, AZ 85713; 520.790.7040; www.ICAAquatics.com

5. Grab Rails and Recessed (Inset) Steps

- a. The grab rails and their gripping surface must comply with Accessibility Guidelines.
- b. Four (4) 6.25-inches [156 mm] deep escutcheon-less Copolymer compression anchors must support the grab rails. One anchor spanner wrench must be supplied with each set of four (4) anchors.
- c. Recessed (inset) treads must be installed flush with the wall and must be a minimum of 5-inches [127 mm] wide, 10-inches [254 mm] long, with a maximum vertical distance of 12-inches [305 mm] between treads. All treads must have a slip-resistant surface. Refer to the Tiles section for contrasting color tiles at the perimeter-edges of the recessed steps.
- d. The Basis of Design: Items must be provided by Inter-Fab Commercial Aquatics, 3050 S. Alvernon Way, Tucson, AZ 85713; 520.790.7040; www.ICAAquatics.com

E. CUP ANCHOR

1. Cup anchor must be fabricated of ASTM-A-554 grade 316L series stainless steel. The cup and the flange portion of the anchor body must be stamped or drawn from a single piece of material. The cup portion must be 3-inches [75 mm] with a depth of 2.5-inches [63 mm]. The face flange must be 4-inches [100 mm] square and must fit flush with the finished pool wall.
2. A standoff must be provided, secure the eyebolt (or integral crossbar), support an anchoring flange, and bonding/grounding screw attachment.
3. The anchor bolt / integral crossbar must be provided. The eyebolt must be 18-8 stainless steel. The eyebolt / integral crossbar must be flush with the anchor body's face flange and provide a minimum 1-inch [25 mm] opening.
4. Supplied by Inter-Fab Commercial Aquatics, 3050 S. Alvernon Way, Tucson, AZ 85713; 520.790.7040; www.ICAaquatics.com
5. Line Anchors: Must be designed and fabricated to withstand forces specified by floating line manufacturers or recognized swimming authority. In the case of a stainless-steel pool, line anchor construction must utilize third-party bracing elements (not solely supported by wall panel) and utilize the structural pool system to provide resistance to service forces (line anchors secured only to wall panels are not permitted).

F. HANDICAPPED ACCESSIBLE LIFT UNIT AND ANCHOR

1. Refer to the Rail Goods – General Requirements
2. Design assisted access lift to be self-operating, powered by the water pressure of no more than 55 psi (379.2 kPa)
3. ADA (Americans with Disabilities Act) Accessible Lift Unit is required where applicable.
4. The lift must support a 400 lb. [181 kg] lifting capacity with a 1.5 safety factor.
5. Provide wheels for removal and transport to storage.
6. Lifting Mechanism: must be the Manufacturer's standard design to facilitate 42-inches [1066 mm] of vertical travel, a stabilizing pressure foot to maintain load stability during load rotation without deflection, and an adjustable base stand with anchor locations at 20.5-inches to 30-inches [520 mm to 762 mm] from the pool wall.
7. The lift must include two 1-inch [25 mm] threaded anchor bolts to secure the anchor assembly lift.
8. The lift's anchor assembly comprises two jig-mounted threaded in beds located 29 5/8-inches [752 mm] O.C. The preset assembly must include a bonding/grounding UL-Listed ground lug for proper bonding.
9. Provide 2 valve control handles requiring less than 5 lb. [2.2 Kg] of pressure to operate. Locate at both deck and pool levels adjacent to the seat at resting position. The valve control must not require continuous manual pressure to operate.
10. Include a self-adjusting stainless-steel footrest. The footrest surface must be 10-inches by 8-inches [254 mm by 203 mm] and swivel to accommodate the self-adjustment feature.
11. Metallic components of the lift must be fabricated of ASTM-A-554 316L-stainless steel. The finished surface must be a polished number 6-finish
12. Provide a seat assembly that meets or exceeds the Type "A" Seat per ASTM seat standards, and the following:
 - a. Size: 18-inches [455 mm] high, 18-inches [455 mm] wide and 17¼-inches [455 mm] deep, double contour design.

- b. The seat must fold down with a “No-Pinch” hinge and stainless-steel hinge pins
 - c. Include a rigid inner transfer arm and flip-up outer arm.
 - d. Seatbelt Assembly: Wide synthetic webbed belts with a quick release, non-metallic, cam-lock buckle.
13. Water Box: Stainless steel, 8-inches [200 mm] wide by 8-inches [200 mm] long by 6.125 inches [155 mm] deep with vandal-proof cover.
- a. Factory-cut one 1.125 inches [28 mm] diameter hole in the sidewall to allow for the water supply line.
 - b. Plumb a hose spigot into the water box, allowing for the connection of a flexible hose.
 - c. The factory cut a hole in the removable lid for the hose to pass through.
14. If insufficient water pressure is available for lift operations, then provide the following pressure amplification system: ½-HP, single-phase, 60-cycle, 3450 RPM, stainless steel centrifugal pump.
- a. The unit must have a performance rating of 5 GPM [1.385m³/h] at 60 psi [413.7 kPa]. The system must employ a hydro-pneumatic pressure-sustaining tank having a maximum working pressure of 100 psi [689.5 kPa] with a 3/4 inch [20 mm]-NPTM tank connections as a holding reservoir.
 - b. Control the pump’s operation via a field-adjustable pressure switch allowing for adjustment of cut-in and cut-out pressure.
 - c. The pump must be equipped with a 0.75-inch [20 mm], brass, spring-loaded check valve designed to retain water pressure accumulated within the pressure-sustaining tank.
 - d. Include 50-feet [15.24 m] of 0.375-inch [9.5 mm] Nylon Seal[®] tubing and necessary tubing connectors.
15. Provide Manufacturer’s standard:
- a. “Flush plug” to cover the lift deck anchor when not in use.
 - b. Include a warning sign, double-stitched to the cover visible from the pool deck when in use.
16. Battery operated lifts must have a completely sealed, watertight battery, intended for use in the pool environment.
- a. Items must be by Inter-Fab Commercial Aquatics, 3050 S. Alvernon Way, Tucson, AZ 85713; 520.790.7040; www.ICAquatics.com

G. POOL SAFETY & RESTROOM SIGNS

1. Custom fabrication of signage must include:
- a. Sign size established by the Architect
 - b. Aluminum-sign fabrication with baked enamel finish. Color: White
 - c. Fabricated aluminum frame with stainless steel 316 hardware suitable for wall mounting.
 - d. Dark contrasting lettering – a minimum of 1-inch [25 mm] high (upper case only)
 - 1) Exception: “NO DIVING” rule must be a minimum of 4-inches [100 mm] high (upper case only).

- 2) Refer to the Drawings for the recommended rules for the pool(s) operations.
2. Restroom location signage and Door Signage
 - a. Customize the directional arrow nature of the sign to point toward the location of the restrooms.
 - b. Sign size must be established by the Architect (with materials & colors). Each restroom related sign must have a minimum 1-inch [25 mm] high (upper case only) dark, contrasting letters, and a correctly-located directional arrow.
 - c. Place signage on each restroom door to read "MEN," "WOMEN," or "UNISEX."
3. Water Toys – Refer to the specific manufacturer for all safety rules and required signage.

H. POOL ACCESSORIES

1. Safety and Cleaning Poles: one-piece, 16-feet [4.87 m] long minimum.
2. Metallic Hardware for Slides: 316L stainless steel or epoxy coated.

2.09 NOT USED

2.10 PUMPS

A. GENERAL

1. Refer to pump schedules for pump type ratings, water flows, heads, motor speed, enclosure, efficiency, NPSH-R value, and power requirements. The unit must be suitable for the conditions shown on the pump schedule.
2. Mount pump on a rigid, single-piece base plate, with grouting hole, connected by flexible coupling with a guard to an induction type motor of IE-3 if metric and NEMA Premium (12.12) if Imperial premium efficiency level, suitable for VFD duty rated, and slow-starting.
 - a. Exception: Vertical type pump motors may be provided with custom supports in place of a base plate.
3. Unless otherwise noted in the "Pump-Type" ratings, pump construction must be cast iron and be fitted with a long-life, product lubricated, drip-tight EPDM or VITON mechanical seal, with O-ring seat retainer, designed for the specified maximum temperature and pressure and quiet operation.
4. Casings must be designed for scheduled working pressure and can withstand hydrostatic test at 150% of the maximum working pressure under which the pump could operate at design speed.
5. The design of the pump must include ease of maintenance with machine fit parts that are easily disassembled.
 - a. A coupling, capable of absorbing torsional vibration and operating in variable speed applications, must be installed between the pump and motor.
 - b. A spacer coupler must be fitted to remove the pump's wetted end without disturbing the pump volute or movement of the pump's motor and electrical connections.
 - c. Each metallic pump & motor must be equipped with a bonding/grounding UL-Listed lug sized to accommodate a #8 solid copper conductor encapsulated with waterproof insulation.

B. FEATURES SPECIFIED FOR CENTRIFUGAL PUMPS (TYPES A through J):

1. Impeller shaft:
 - a. The impeller shaft must be a solid 416 stainless steel, heat-treated to 80 KSI yield strength, and be supported with two heavy-duty ball bearings. The design must allow back pull-out servicing, enabling the assembly to be removed without disturbing the casing piping connections.
2. Bearing Housing:
 - a. The bearing housing must supply support for a single row of permanently lubricated heavy-duty ball bearings, with provision for purging or flushing. Grease bearings with polyurea grease can handle high and low temperatures and are resistant to washout and condensation.
 - b. The bearings must absorb both radial and thrust loads and maintain the rotating element in axial alignment.
 - c. Bearings must be capable of being inspected and repaired by the removal of only a bearing bracket.
3. Mechanical Seals
 - a. The pump's mechanical seal must be Stainless Steel multi-spring balanced type with silicon carbide faces incorporating EPDM or VITON secondary seals.
 - b. Provide stainless steel gland plate with stainless steel trim.
 - c. Provide factory-installed flush line with manual vent.
 - d. Seals must be capable of being inspected and easily repaired without disassembling the pump and its piping connections.
 - e.
4. Impeller:
 - a. The impeller must be of the enclosed double suction type made of low zinc silicon brass or stainless steel - both hydraulically and dynamically balanced to ISO 1940-1:2003 balance grade G6.3 and keyed to the shaft
5. Volute:
 - a. The pump volute must be cast iron ASTM A159 (35,000 psi [241.32 mPa]) with an integrally cast pump discharge and pump suction.
 - b. Flanges must be extra heavy-duty, 250# thickness, while capable of being drilled for 125# ANSI flat face use. Volute must have integrally cast support feet, gauge ports at nozzles, and vent and drain ports.
6. Fusion Bonded Coating:
 - a. Factory coat to protect internal cast iron wetted components with Scotchkote 134, fusion bonded coating by 3M with a Thickness of 8 to 12 mils.
 - 1) Exception: Impellor or similar components
 - b. Primer: Refer to the manufacturer's recommended primer for the indicated substrate.
7. Motor:

- a. Motors must meet scheduled horsepower, rotational speed, phase & voltage, and totally-enclosed-fan-cooled enclosure design (TEFC). Pump and motors must be factory aligned to be realigned after installation (before operation) by the manufacturer's representative.
 - b. Motors must be non-overloading at any point on the pump curve and meet NEMA specifications conforming to the standards outlined in EPACT 92.
 - c. Motors must be Premium Efficient IE-3 if metric and NEMA Premium (12.12) if Imperial, TEFC individually rated, listed for variable frequency drive/inverter duty, and slow start.
 - d. Motors must have Class F (or higher) insulation for efficient operations, explicitly identified, with duty-rated for VFD duty, and slow start.
 - e. Provide each motor with terminal blocks/terminal lugs for power connection.
 - f. Each motor (larger than 25-hp [18.64 kW]) must have a shaft grounding ring system.
 - g. A manufacturer-supplied performance chart with an NPSH-R value is mandatory for each pump.
8. Seismic:
- a. Each pump's seismic capability must allow it to withstand a horizontal load of 0.5g, excluding piping and fasteners used to anchor the pump to mounting pads, without adversely affecting pump operation.
9. Testing & Paint Color:
- a. Each pump must be hydrostatically tested, painted with two coats of high-quality factory approved paint, and name-plated before shipment. Color: Red, unless noted otherwise.
10. Accessories:
- a. Internal bronze casing wear-rings, galvanized drip pan on the base, and unique spacer-couplers.
- C. FEATURES SPECIFIED FOR CLOSE-COUPLED CENTRIFUGAL PUMPS (TYPE L):
- 1. The pump must be NSF-50 listed.
 - 2. Pump Construction:
 - a. The water pumps must be close-coupled, single-stage, with an integrated Hair & Lint Strainer pre-filter adaptable and designed for vertical installation.
 - b. The pumps must have the following construction:
 - 1) The pump casing, intermediate casing, and casing cover material must be close-grained cast iron ASTM A48 Class 30B with a minimum tensile strength of 30,000 P.S.I.
 - 2) Volute must have integrally cast suction and discharge connections, gauge ports at nozzles, and vent and drain ports.
 - 3) Impeller: Copper-aluminum cast alloy ASTM B148 UNS C95800
 - 4) Case wear ring: Herborner Pumpen Polyoxymethylene Impeller Protector
 - 5) Motor Shaft: 316 Stainless Steel
 - 6) A shaft sleeve must not be provided or required due to optimally balanced mechanical sealing connections and shaft material while manufacturing.

7) Mechanical Seal: Silicon Carbide with FKM Rubber with by-pass channel and flushing device for lubrication and cooling medium

a) Optional Mechanical Seal: Carbon with Nitrile Rubber (NBR)

3. General:

- a. Casings must be designed for scheduled working pressure and can withstand hydrostatic test at 150% of the maximum working pressure under which the pump could operate at design speed.
- b. The pump must be of a rear pull-out design to allow servicing without disturbing piping.
- c. Pump Discharge Variable flange positions in 45° increments offering optimum design possibilities to reduce fittings at the pump.
- d. Closed multi-vane, copper-aluminum cast alloy impeller with a minimum of 95,000 PSI tensile strength against cavitation, corrosion, and abrasion resistance.
- e. Impeller hydraulically and dynamically balanced to ISO 1940-1:2003 balance grade G6.3 and keyed to the shaft.
- f. The impeller must be trimmed to meet the specific hydraulic requirements when not used with a Variable Frequency Drive.
- g. Flow-optimized casing design with large drain screw plug for cleaning without the need for tools.
- h. The pump must be equipped with Hair & Lint Filter strainer and provided with
 - 1) 0.12-inch diameter perforations to ensure a high degree of separation of debris.
 - 2) A transparent filter cover must be provided for easy access to clean the filter basket.
- i. Pump rotation must be clockwise as viewed from the motor end.
- j. A ball valve and connection for pump venting must be provided for air accumulation discharge.
- k. All screws, washers, and nuts are constructed of 316 Stainless Steel.
- l. X-Lock System: All threading is provided with an internal accessory for 100% corrosion protection in threads.
- m. Motors starting with 1.5 HP and higher must be provided with a relubrication port and kit from the manufacturer.
- n. Each pump must be factory tested and name-plated before shipment.
- o. The pump must be designed for ease of maintenance and should use machine fit parts that are easily disassembled.
- p. Except for the coated part acc. to chapter 2.2, each pump must be painted blue with one coat of high-quality factory approved paint and name-plated before shipment from the factory. Color specific paint may be provided upon request.

4. Coating

- a. Volute, intermediate casing and suction and discharge connections must be entirely coated from medium-contacting areas and external sections with HPC (Herborner Pump Coating) system thickness of 20 up to 24 mils providing 100% corrosion protection.
 - 1) HPC coated sections must be black.

- b. The coating of cast iron materials must be of equal endurance to bronze construction.
- c. Coating only medium wetted cast iron surfaces of volute and bracket and fusion bonded epoxy is prohibited.
 - 1) Fusion bonded epoxy coating may only be accepted in the filter housing area.
 - 2) The coating must be proven to provide an extremely smooth surface for optimal efficiency savings and cavitation prevention damage.
- 5. Additional Features Required:
 - a. Seal Guard System with O-ring
 - 1) Media Reservoir must be provided to protect the mechanical seal from dry running.
 - 2) Mechanical Seal must be further protected with a nitrile rubber O-ring. The mechanical seal seat is 100% protected against corrosion.
 - b. Filter strainer
 - 1) Additional filter strainer for the replacement to keep the downtime of the pump as low as possible.
 - c. Long Life Set
 - 1) High-performance grease and gun must be provided to increase the life of motor bearings.
 - d. Analog or Digital Pressure Unit
 - 1) A pressure sensor must be provided to indicate the degree of contamination of the filter strainer or pump performance measure.
- 6. Motors
 - a. The pump electric motor must be factory provided and assembled at the manufacturer's approved representative's facility. The pump manufacturer must have complete unit responsibility. No field-assemblies must be accepted.
 - b. Motors must meet scheduled horsepower, speed, voltage, and enclosure design.
 - c. Shaft seal ring and anti-friction bearings on both non-drive and drive sides. Drives sides must be equipped with double-row bearings.
 - d. The motor must be close-coupled type and be non-overloading at any point on the pump curve and must meet NEMA 3R specifications.
 - 1) The motor must be TEFC Super-E® Pump Motors (IE3) with AEGIS® Bearing Protection Ring, a Permanent Magnet Motor (IE5)
 - 2) The motor must meet or exceed the minimum full load efficiencies as per Super-Efficient NEMA Premium motors.
 - 3) The motor ball bearings must be selected to withstand thrust loads and have a minimum life of L-10 25,000 life hours.
 - e. Class F insulation
 - f. Refer to the Drawings for design & performance specifications
- 7. Basis of Design: Herborner Pump, Models FN, and Model XN; Manufacturer's Representative: Aquafy Systems, Attn: Ryan McDowell, www.aquifysystems.com

E: ryan@aquifysystems.com ; Direct: 1.250.808.6060; Office: 1.833.386.2782; 201 - 460
Doyle Ave, Kelowna, BC, Canada, V1Y 0C2

D. PRE-APPROVED PUMPS - SPECIFIC TYPE AND CLASS RATINGS

1. Type: Refer to below listing for requirements of specified pump class':

PUMP TYPE	SPECIFIED ATTRIBUTES / FEATURES	Manufacturers / Series
A	<ul style="list-style-type: none"> • Class: Flooded Suction Centrifugal Pump • Split-Coupled Vertical Inline Pump with Motor Integrated Pump Mounted Controls • The integrated control enclosure must be NEMA 4X type. • Stainless Steel Type 416 Pump Shaft with Outside Balanced Mechanical Seal. • Couplings must be split to remove pump and motor shafts, leaving space between the shafts sufficient to replace mechanical seal components without disturbing the pump or motor. • Seal Construction: Silicon Carbide Seat, Resin Bonded Carbon Rotating Face with EPDM, or VITON Elastomers. Seal hardware must be 316L Stainless Steel • Pump volute must be coated with an NSF approved low VOC epoxy on the interior and external surfaces. • Motor enclosures must be TEFC with Terminal Blocks • Motor Efficiency: NEMA Premium (12.12) compliant with NEMA MG-1 Part 31.4.4.2 for inverter-fed poly-phase motors. IE-3 is compliant in metric projects. • 1,750 RPM or less (Maximum Rotational-Speed) • When the motor is greater than 25-hp, equip with an AEGIS SGR motor-shaft grounding system factory installed and tested. The site installation of SGR is not allowed. • The pump must be compliant with NSF Standard 50-211. 	Armstrong 4300
B	<ul style="list-style-type: none"> • Class: Flooded Suction Centrifugal Pump with Vertical In-Line Construction • Stainless Steel Pump Shaft / Sleeve with EPDM or VITON Seals • Epoxy Fused Coating on Wetted Parts • TEFC Motor Enclosure with Terminal Blocks 	Marlow 580 Marlow e-580

	<ul style="list-style-type: none"> Premium Efficiency Motor IE-3 for metric and NEMA Premium (12.12) for imperial Class F Insulation (or better) Inverter / VFD Duty Rated Motor at 1,750 RPM or less (Maximum Rotational-Speed) When the motor is greater than 25-hp, equip with a Shaft Ring Mounted Grounding System NSF Standard 50 Listing Compliant 	
C	<ul style="list-style-type: none"> Class: Flooded Suction Centrifugal Pump with Horizontal Construction Stainless Steel Pump Shaft / Sleeve with EPDM or VITON Seals Epoxy Fused Coating on Wetted Parts TEFC Motor Enclosure with Terminal Blocks Premium Efficiency Motor IE-3 for metric and NEMA Premium (12.12) for imperial Class F Insulation (or better) Inverter / VFD Duty Rated Motor at 1,750 RPM (Maximum Rotational-Speed) When the motor is greater than 25-hp, equip with a Shaft Ring Mounted Grounding System NSF Standard 50 Listing Compliant 	Marlow 530SC Marlow e-530SC Marlo e-531SC
D	<ul style="list-style-type: none"> Class: Self-Priming Centrifugal Pump with Horizontal Construction Flanged Suction and Flanged Discharge Epoxy Fused Coating on Wetted Parts TEFC Motor Enclosure with Terminal Blocks Premium Efficiency Motor IE-3 for metric and NEMA Premium (12.12) for imperial Class F Insulation Inverter / VFD Duty Rated Motor at 1,750 RPM or less (Maximum Rotational-Speed) Steel Pump Shaft with Replaceable Bronze Shaft Sleeve with EPDM or VITON Seals Bronze Impeller Integral Suction Strainer with Stainless Steel Strainer Basket NSF Listing Standard 50 Listing Compliant 	Marlow 4SPC
E	<ul style="list-style-type: none"> Class: Self-Priming Centrifugal Pump with Horizontal Construction Flanged Suction and Flanged Discharge Cast Iron Hydraulic Body with Epoxy Fused Coating on Wetted Parts TEFC Motor Enclosure with Class F or better Insulation 	Marlow EL Marlow EC

	<ul style="list-style-type: none"> Premium Efficiency Motor IE-3 for metric and NEMA Premium (12.12) for imperial with Class F or better Insulation Inverter / VFD Duty Rated Motor at 1,750 RPM or less (Maximum Rotational-Speed) Stainless Steel Pump Shaft or Stainless-Steel Shaft Sleeve (Close-Coupled) EPDM or VITON Seals on 3PL and 4PL Only Cast Iron Impeller NSF Listing / NSF Standard 50 Listing Compliant 	
F	<ul style="list-style-type: none"> Class: Self-Priming Centrifugal Pump with Horizontal Construction Union-Coupled Suction and Discharge NORYL, Thermoplastic Housing Hydraulic Body TEFC Motor Enclosure with Class E Insulation Inverter / VFD Ready Rated Motor at 3,550 RPM or less (Maximum Rotational-Speed) Stainless Steel Pump Shaft / Sleeve with VITON Seals Integral Non-Corrosive Strainer Basket with Transparent Cover Lid NSF Listing / NSF Standard 50 Listing Compliant 	Hayward HCP Series Pentair Whisperflo- XFK Series EQK Series
G	<ul style="list-style-type: none"> Class: Self-Priming Centrifugal Pump 4-inch Suction and 3-inch Discharge Female NPT Pipe Connections Cast Iron Hydraulic Body with Epoxy Fused Coating on Wetted Parts ODP Motor EPACT Efficient EISA Compliant with Class F Insulation Inverter / VFD Ready Rated Motor at 3,550 RPM or less (Maximum Rotational-Speed) Steel Pump Shaft with Replaceable Bronze Shaft Sleeve with EPDM Seals Cast Iron Impeller Integral Suction Strainer with Stainless Steel Strainer Basket NSF Listing / NSF Standard 50 Listing Compliant 	Marlow 3B
H	<ul style="list-style-type: none"> Class: Self-Priming Centrifugal Pump with Horizontal Construction FIP Suction and Discharge Pipe Connections NORYL, Thermoplastic Housing Hydraulic Body ODP Motor at 3,450 RPM or less Integral Non-Corrosive Strainer Basket with See-Through Cover Lid NSF Listing / NSF Standard 50 Listing Compliant 	Hayward Tri-Star-SP- 32x Series Pentair WhisperFlo Challenger Sta-Rite Max-E-Pro Dyna-Pro

		Intelliflo
I	<ul style="list-style-type: none"> • Class: Self-Priming Trash Pump • Rated for solid laden liquids, slurries, and sludge • FIP Threaded Connections • Cast Iron Hydraulic with Built-In Buna-N Check Valve • Stainless Steel Impeller (Self-Cleaning) and Stainless-Steel Shaft • TEFC Motor Enclosure at 3,450 RPM or less with Class F Insulation • Stainless Steel Pump Shaft with EPDM or VITON Seals 	AMT 3xxx-95 Series
J	<ul style="list-style-type: none"> • Class: Submersible Pump • Rated for solids with diameters up to 3-inches • Flanged Discharge • Cast Iron Hydraulic Body with Epoxy Fused Coating on Wetted Parts • TEFC Motor Enclosure to be Premium Efficiency IE-1 with Class F Insulation • Inverter / VFD Duty Rated Motor at 1,750 RPM or less (Maximum Rotational-Speed) • Stainless Steel Pump Shaft with EPDM or VITON Seals • Equipped with Float Level Controls 	Barnes 3xSE Series 4xSE Series Deming 7365 Series
K	<ul style="list-style-type: none"> • Class: Submersible Vertical Turbine • Inverter/VFD Duty Rated Motor at 3450-3480 RPM • Shaft Seal SIC/SICNBR • 4-inch Pump 6-inch Motor Impeller Integral Check Valve: Constructed of AISI 304 (or better) Stainless Steel • 4-inch FNPT Pump Discharge Connection • Liquid Rated: Water Max temperature. 104°F • Power: KVA Code J 460/480V, 3PH, 60Hz • Service Factor: 1.15 • Enclosure Class: (IEC 34-5) IP68 • Insulation Class (IEC 85) F • Thermal Protection: External w/Built-in transmitter • Cooling Jacket with Inlet Filter; AISI 304 (or better) Stainless Steel • 	Grundfos
L	<ul style="list-style-type: none"> • Class: Flooded Suction Centrifugal Pump with Vertical In-Line Construction • Pump Casing W2B: Grey Cast Iron ASTM A48 Class 30B 	Herborner Models FN & XN

	<ul style="list-style-type: none"> • Impeller: Copper-aluminum cast alloy ASTM B148 UNS C95800 • Case wear ring: Herborner Pumpen Polyoxymethylene Impeller Protector • Motor Shaft: 316 Stainless Steel • Mechanical Seal: Silicon Carbide with FKM Rubber with by-pass channel and flushing device for lubrication and cooling medium • Epoxy Fused Coating on Wetted Parts • The motor must be TEFC Super-E® Pump Motors (IE3) with AEGIS® Bearing Protection Ring, a Permanent Magnet Motor (IE5) • The motor must meet or exceed the minimum full load efficiencies as per Super-Efficient NEMA Premium motors. • The motor ball bearings must be selected to withstand thrust loads and have a minimum life of L-10 [25,000 life hours]. • TEFC Motor Enclosure with Terminal Blocks • Premium Efficiency Motor IE-3 for metric and NEMA Premium (12.12) for imperial Class F Insulation (or better) • Inverter / VFD Duty Rated Motor at 1,750 RPM or less (Maximum Rotational-Speed is 1,750 RPM) • When the motor is greater than 25-hp, equip with a Shaft Ring Mounted Grounding System • NSF Standard 50 Listing Compliant 	
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2.11 STRAINERS

A. INTEGRAL TYPE

1. The Basis of Design: Integral strainers as supplied with
 - a. Pentair Commercial type pumps
 - b. Hayward Commercial type pumps

B. LARGE HAIR & LINT STRAINERS

1. Stainless steel 316L is not less than 11-gauge.
 - a. The unit must be equipped with a more substantial influent, flanged connection with a smaller eccentric-reducer-type effluent, flanged connection.
 - b. The upper hemisphere of the influent and effluent piping must require that the strainer serves as an eccentric reducer.
 - 1) Strainer units that do not allow the piping to reduce in size across the strainer body are disallowed.

- 2) Any filtration system pump which takes suction directly from the slide plunge pool and reservoir must have a minimum 8-inches [208 mm] diameter hair and lint strainer on the pump's suction side.
- c. The open-area ratio of the influent pipe cross-sectional area compared to the cumulative area of the openings in the baskets must not be less than a ratio of 19 to 1.
2. The welding process must be T.I.G. Parts must be fitted and welded per approved standard-practices as defined by the American Welding Society regulations regarding the TIG welding of stainless steel. The assembly must be sealed and purged with argon or other inert gas as approved by the AWS. The filler rod must be 316 stainless steel or better.
3. The circumference of the strainer body must be parallel to the direction of the entering fluid. Entering fluid must enter the baskets' open-end entrance unimpeded. A solid partition between the baskets at the influent end must also serve as a sizeable debris-catching bar. Basket configuration: Not less than four continuous flow paths, 90 percent the strainer body's length.
4. The influent and effluent nipples and flanges must be 316L stainless steel.
 - a. Flange thickness: Minimum 0.25 inch [6 mm] for 4-inches [100 mm] diameter flanges and smaller; and not less than .50 inch [13 mm] for 5-inches [125 mm] diameter flanges with the bolt arrangement pattern to match ANSI standards in size, dimension, quantity, and location.
 - b. The nipple portion must be rolled to the standard ANSI pipe diameter and seam welded. The nipple must be inserted 1/8 inch [3 mm] into the flange and have a continuous sealing weld connecting the two.
 - c. Exception: Metric sized flanges' bolt patterns must match DIN standards.
5. The lid must be a minimum of 0.5-inches [13 mm] thick transparent polycarbonate sheet with manufacturer-supplied reinforcing to prevent excessive vacuum loads.
6. Lid bezel: 11-gauge stainless steel Type 316L. Mechanically fasten the bezel to the lid with a minimum of twenty stainless steel Allen head screws. The lid must be one-piece cut to size and not have any holes or penetrations. Each glazing beam provided handle openings incorporated into the vertical portion of the glazing beam.
7. Gasket material: Premium-grade EPDM, VITON, or neoprene. The gasket must be 0.25 inch [6 mm] high by 0.25 inch [6 mm] outside dimension width conforming uniformly to the lid receptor area's dimensions.
8. The strainer must include a lid securing system comprised of stainless-steel draw latches with a maximum working pressure of 2250 psi [15.51 mPa] and a burst pressure rating of 2400 psi [16.54 mPa]. Each draw latch bracket must be TIG welded to the body of the ProStrainer. Provide 10 per strainer. Each draw latch must be pressure adjustable by hand tightening a metal thread claw. Each of these operations must be accomplishable without the use of tools.
9. Provide one FPT half coupling welded to the central lowest point on the strainer body. Provide threaded brass or stainless plug screwed in strainer body accessed and serviced from outside the strainer body.

- a. The drain nipple must have threads on the exterior to allow for a standard pipe connection and an external drain valve.
 - 10. Strainer baskets: Provide 316L perforated stainless steel mesh and frame with 0.125 inch [3.2 mm] perforations, not less than 71% open area. Provide manufacturer's standard retractable handle. The strainer assembly must be provided with a minimum of two internal-baskets (per strainer).
 - 11. Strainer Limitations: Strainers must be operated upstream of pumps with a VFD or a Motor Starter with a soft-start.
 - 12. The Basis of Design: ProStrainer™ Model by Neptune Benson, Inc.; 6 Jefferson Drive, Coventry, Rhode Island 02816, (401) 821-2200; www.neptunebenson.com
 - a. Cast-iron, coated cast-iron, or fiberglass strainers are disallowed.
- C. HIGH FLOW VOLUME FILTER STRAINERS
- 1. Strainers:
 - a. Housing: Carbon steel with factory-applied primer and topcoat. Color RED.
 - b. Equip units with a semi-automated motorized brushaway feature or equivalent. Refer to the Equipment Schedules.
 - c. A clogging indicator must be provided in each unit.
 - d. Maximum pressure: 150 psi [1,034.2 kPa]
 - 2. Screen Elements:
 - a. Construct screens from molded plastic ribs that support a stainless-steel weave wire screen with filtration sized at 500 microns. Verify the micron size rating before ordering.
 - b. Remove inorganic suspended solids using an automatic flush valve.
 - c. The element cylinder must incorporate two O-rings to confirm sealing inside the filter housing.
 - 3. Construction Materials:
 - a. 500 mm to 3500 mm
 - 1) Housing: Phosphate pre-treated steel 37-2 with polyester coating
 - 2) Lid: SMC polyester
 - 3) Seals: Nitrile rubber
 - 4) Perforated stainless steel screens: Stainless Steel #316L
 - 4. The Basis of Design:
 - a. Brushaway Model; Amiad USA Inc. Main Office & Manufacturing: 120-J Talbert Road, Mooresville, NC 28117, Tel: +1 704.662.3133, Fax: +1 704.662.3155, Toll-Free: +1 800.24 FILTER, E-mail: infousa@amiad.com www.amiadusa.com
 - b. Auto-Cleaning Steel Filter; Timex, Gidacilar Caddesi 1064. Sokak No:10 Saray-Kazan/ANKARA, Turkey; +90 312 815 52 46; info@timex.com.tr; <http://www.timex.com.tr/eng>

2.12 FILTERS

A. GENERAL

- 1. Certifications: The filter(s) must bear the NSF Seal of Approval per NSF Standard 50.

- a. The filter area must be listed in NSF-Standard 50 to provide the specific filter flow rate. No adjustment, modification, manipulation, or interpretation of these values must be permitted.
 2. Metallic tanks must be equipped with a UL-Listed bonding/grounding lug sized to accommodate a #8 solid copper conductor encapsulated in waterproof insulation.
 3. Refer to the Drawings for tank connection sizes.
 4. Unless hydraulically justified by This Engineer and is in The Drawings, the following filters types must have the noted minimum TDH in Feet:
 - a. Vacuum Cartridge or DE Systems: 50-feet TDH; Include vacuum gauge 0-30 Inches of Mercury with a minimum 2-inch face
 - b. All others (Pressure Vessels): 60-feet TDH; Include 2 pressure gauges 0-60 PSI, each with a minimum 2-inch face
 5. A mandatory sight glass / clear pipe segment 2-Feet [600 mm] in length must be provided on:
 - a. Hi-Rate Sand filter – backwash pipe
 - b. All Filters – upstream of the flow meter
 6. Each outdoor-located filtration system must be manufacturer-rated for outdoor use. All tubing must be metallic and impervious to rain and UV damage
- B. HI-RATE SAND FILTER SYSTEM:**
1. Performance Criteria: Filter system must be the pressure type, horizontal in configuration, suitable for a single grade of filter media, and bear the listing mark of the National Sanitation Foundation (NSF) Standard 50 for a maximum flow of 15 GPM [57 L/min] per square foot of filter area with a maximum pressure loss across any filter tank, when clean, of 10 psi [68.9 kPa]; however, refer to the Drawings for the specific filter area for this project and its corresponding flow rate per square foot.
 - a. Exception: A maximum flow per square foot may be as high as 20 GPM/Square Foot only if the NSF listing allows explicitly such a flow rate
 - b. Exception: Hi-rate sand filters used on slide plunge pools are limited to 50% of the NSF listed filter flow rate. For example: if the maximum filter flow rate is commonly 20 GPM/SF, then on a slide plunge pool, the maximum filtration rate must be limited to 10 GPM/SF.
 - c. Refer to the Drawings for maximum water flow per filter.
 - d. The backwash cycle for each filter system must be automatically controlled. Reverse flow backwash of the filter system with raw, unfiltered water must not be acceptable. Refer to the piping schematics for the connection sizes specified for each filter.
 - e. Filter Tanks: Tanks must be seamless, composite construction (and include a molded inner tank) pad, and suitable for the working pressure of 100 psi [689.5 kPa] with a minimum safety factor of 4 to 1 and a vacuum of 25-inches [635 mm] of mercury.
 - f. The tank must be fitted with various fittings and openings as detailed to meet the performance requirements.
 - g. The tank must be provided with an access maintenance hole with a yoke, cover, and gasket along the tank's side to permit media loading and service.

- 1) Sand-filter tanks to have an air-relief valve,
 - 2) effluent pressure gauges with a minimum face size of 2-inches [50 mm] reading 0–60 psi [0–414 kPa], and
 - 3) a clear sight glass when a backwash line is required.
 - 4) Vacuum filter systems must be equipped with a vacuum gauge with a 2" (51 mm) face and with a calibration range from 0 to 30 inches of mercury.
 - h. The design supports to accommodate Seismic Zone 4 installation. Necessary mounting hardware must be furnished along with an anchor bolt setting template.
 - i. Internal Distribution and Collection System: Each filter vessel must have a suitable sized internal distribution and collection system hydraulically balanced to prevent the filter media's migration during filtration cycles without channeling or breakthrough. The entire internal distribution system must be constructed of plastic materials. Internal components must be removable for repair or replacement.
 - j. Backwash System: Automatic.
 - 1) Provide a sight glass or clear PVC pipe mounted on the backwash line.
 - k. Controls: Fit filter system with a control console that automatically controls the filter system's operation, pool heater, and related chemical feeder controls. Include a digital flow meter to provide a "gpm" reading output onto the control panel LED indicator.
 - l. Filter Media Compatibility: The filter manufacturer must supply sand (filter media) to verify compatibility with these sand filters.
 - 1) Filter media silica sand must be angular with a roundness value between 0.0 - 0.20.
 - 2) The uniformity coefficient must not exceed 1.50.
 - 3) Specific gravity is not less than 2.5.
 - 4) Minimum hardness: 7 Mohs.
 - 5) Effective grain size: 0.49 mm.
 - 6) No exceptions without the manufacturer's written approval.
 - m. Electrical Rating: 120 VAC/60-hertz electricity: Power consumption must not exceed 12 amps.
 - n. Pressure Amplification System: Provide the specified pressure amplification system necessary to produce a minimum of 50 psi [344.7 kPa] for filter backwashing via the automatic valves.
 - o. All materials must be manufacturer-rated for outdoor use, rain event and UV-resilient, weatherproof without exception, & all tubing & fittings must be metallic non-corrosive.
 2. The Basis of Design: Model SHFFG (Horizontal Fiberglass High Rate Sand Filters) as manufactured by Neptune Benson, 6 Jefferson Drive, Coventry, Rhode Island 02816, (401) 821-2200; www.neptunebenson.com
- C. CARTRIDGE FILTER SYSTEM:
1. Commercial Cartridge Filter

- a. Pressure filter assemblies must consist of the filter tank, multiple filter elements, union-type connectors, gauges, air-relief valves, influent/effluent pressure gauges (2" minimum face diameter), and a sight glass in the waste line, and similar equipment.
 - 1) Vacuum cartridge filter assemblies must comply with the above plus has a minimum 2-inch diameter vacuum gauge capable of reading 1-30 inches of mercury
- b. Components and materials must have been tested and approved using NSF Standard 50, latest edition. All cartridge elements used in public pool filters must be permanently marked with the manufacturer's name, pore size, and area in square feet of filter material.
- c. The design flow rate divided by the provided filter area must not exceed 0.375 gpm/square foot. Refer to the Drawings for the filtration system and model required for this pool and its related flow rate.
 - 1) Exception: Cartridge filters used on slide plunge pools are limited to 50% of the NSF listed filter flow rate. For example: if the maximum filter flow rate usually is 0.375 GPM/SF, then on a slide plunge pool, the maximum filtration rate must be limited to 0.1875 GPM/SF.
- d. The head loss with clean filter elements must not exceed 4 psi at the design flow rate
- e. All materials must be manufacturer-rated for outdoor use, rain event and UV-resilient, weatherproof without exception, & all tubing & fittings must be metallic non-corrosive.
- f. Provide cleaning chemicals such as degreaser, and a utility sink, sump, or tub, for cleaning the filter elements
- g. Refer to the Equipment Schedule for detailed information.

D. PORTABLE VACUUM FILTER SYSTEM:

1. Provide self-contained vacuum unit(s) intact with pump (with an integral hair & lint strainer), filter, piping, valving, vacuum hoses, poles, vacuum heads, 100-feet [30 m] extension cord, and wheeled units for easy transport.
2. Coordinate the supply voltage with the vacuum assembly unit provided.
 - a. The Basis of Design: Model "Wildcat E2" by Spectrum Aquatics, (800) 791-8056, 7100 Spectrum Lane, Missoula, Montana 59808. www.spectrumproducts.com
 - b. Verify available project voltage before ordering.

2.13 CABINETS, PLASTIC STORAGE SHELVING, AND TANKS

A. ABOVE-GRADE CHEMICAL TANKS

1. General
 - a. Chemical tanks must be rotationally molded high-density cross-linked polyethylene, one-piece seamless construction, cylindrical in cross-section, vertical in axis, intact with piping inlets and outlets, drains, overflows, and restraint systems.
 - b. Enclosed tanks must be vented; tanks must be provided with entrance manways, level indicators, and UV-resistant exterior coating.
 - c. Tanks must be marked to identify the manufacturer, date of manufacture, and serial number.

d. Fittings and Gaskets:

- 1) Fittings must be installed at the factory.
- 2) Gaskets: Certified by the manufacturer for use in the specified tank with the specified chemical

e. U-Vents: OSHA 1910.106(F) (iii) (2) (IV) (9)

- 1) Each tank must be vented for its material and flow and withdrawal rates expected.
- 2) Tank manufacturer-sized insect screen
 - a) Caution: Insect screen open area may lessen the tank capacity by 1/3.
- 3) Material: PVC or material compatible with the chemical stored.

f. Flange Adapters: may be used to adapt threaded or socket fitting components to 150 psi [1034.2 kPa] flange connections. Adapters must be of a material compatible with the chemical stored.

g. Float indication: The level indicator must be assembled to the tank and consist of PVC float, indicator, polypropylene rope, perforated-interior pipe, PVC roller-guides, clear PVC sight tube, and necessary pipe supports. The level indicator must act inversely to the tank contents and not allow the tank's contents into the sight tube.

h. Manufacturer: Poly Processing Company, P.O. Box 4150, Monroe, Louisiana 71211; 866.590.6845. The manufacturer's representative is CES, 860 Jupiter Park Drive, Suite 2, Jupiter, FL 33458, 800.940.1557; WWW.CESWaterQuality.com

i. Lifting Lugs: A minimum of three lifting lugs must be provided on chemical tanks with more than 3,000 gals. [11 m³].

- 1) Lugs must be designed for lifting the tank when empty.
- 2) Unless otherwise indicated, the bolted sealed top manway must be 17-inches [430 mm] or higher and located in spots easily accessible from the nearest worker-access position.
 - a) The sealed manway must be constructed of polyethylene material.
 - b) The bolts must be chemically compatible with the chemical being stored.
 - c) Gaskets must be closed-cell, cross-linked polyethylene foam, VITON, and EPDM materials.

B. BELOW-GRADE CHEMICAL TANKS

1. General

- a. Below-grade chemical tanks must be rotationally molded high-density cross-linked polyethylene, one-piece seamless construction, cylindrical in cross-section, vertical in axis, intact with piping inlets, outlets, drains, overflows, and restraint systems.
- b. Each tank must have a self-containment / double-wall tank system.
- c. Tanks must be marked to identify the manufacturer, date of manufacture, and serial number.

C. COLLECTOR / SURGE / RESERVOIR TANK REQUIREMENTS

1. General:

- a. Fiberglass Ladders: The tank must be equipped with an integral fiberglass ladder with extendable hand-hold safety provisions.
- b. Leak-proof Requirements: The tank must be manufacturer-certified as waterproof and leak proof.
- c. Socket Geometry: Standard ANSI geometry. Unless otherwise specified herein, Type 2 (Sch. 80 PVC) socket fittings must be stub-mounted with a maximum fitting protrusion from the tank surface of 3-inches [75 mm].
- d. Piping: Provide the overflow piping, specified modulating diversion valves, foot valves, isolation and variable valves, tank level sensors, water fill sensors, water-pressure testing assemblies, & pipe supports as identified within the Drawings.
- e. The collector tank capacity must be at least 1 minute of the recirculated flow unless first justified by This Engineer.

2. Below-Grade Fiberglass Tank:

- a. Construction: Reinforced fiberglass unless indicated to be concrete in the Drawings.
 - 1) Specified Type 2, Sch. 80 PVC fittings must be factory installed. No field-installed fittings are permitted.
 - 2) Each collector, reservoir, and surge tank(s) must be equipped & provided (by the manufacturer) with Sch. 80 PVC water-pressure test assemblies consisting of 2-feet [600 mm] of pipe, slip socket cap on each pipe penetration into the tank, and a pressure gauge for on-site water pressure testing.
 - 3) Lifting Provisions: Provide lifting features to facilitate hoisting. The tank must accommodate lifting without permanent deformation of any part or surface.
 - 4) Shipping Requirements: Before shipping, cap or plug tanks. Prepare the tank for shipping with no external pressures that may affect the tank's integrity or accessories.

3. Below-Grade Concrete Tanks

- a. If a reinforced concrete tank is scheduled, construct the concrete tank per the Drawings and These Specifications.
- b. Xypex water-proof admix C-500-NF is required in the reinforced, waterproof concrete.

D. CHEMICAL CABINETS

1. Chemical cabinets must be lockable, well-vented, equipped with a light assembly (rated for corrosive locations), and large enough to contain the designated chemicals.
2. Cabinets must have a UV-resistant exterior coating.
3. A weatherproof sign/label must be placed on the exterior of the enclosure to signify the chemical contents and the maximum chemical storage capacity

E. PLASTIC STORAGE SHELVING

1. Industrial-grade shelves for chemical & pool equipment rooms
 - a. Manufactured from chemical-resistant HDPE
 - b. Sets up quickly & snaps merely together.
 - c. UV protected.

2.14 CONTROLS & INSTRUMENTATION – FLOW & PRESSURE

A. GENERAL

1. Gauges must have a minimum 2-inches [50 mm] diameter dial face and be readable from 12-feet [3.5 m].
2. Wetted materials must be stainless steel or bronze alloy.
3. Dual-purpose gauges are permitted.
4. Gauges must be remote back-mounted onto the pump gauge panel.
5. Gauges located outdoors must be weatherproof with stainless steel hardware.

B. BACKFLOW PREVENTER

1. Refer to the Architect's project MEP engineer for this design.
2. Recommendations to the project MEP:
 - a. The assembly must be a "reduced pressure principle backflow preventer" of at least 1-inch [25 mm] NPT size. The actual backflow preventer must match (in size) the auto-fill / manual fill pipe size.
 - b. The unit must be rated for supply pressure up to 175 psi [1,206.6 kPa] and water temperatures up to 180° F [75° C].
 - c. Material: Bronze
 - d. Required Accessories: shut off valves on both sides.
 - e. Recommended Accessories: union connections, strainer
 - f. The Basis of Design: Watts LF009M2-QT by Watts Water Technologies Company; Lawrence, MA 01842; 617.688.1811.

C. FLOWMETERS

1. Each filtration system must be provided with a remote-reading flow meter sensor installed on the pump-return flow-adjusting valve (after the filter and heater). A 4-20 mA signal is preferred.
2. All electronic flowmeters must be equipped with a local numeric readout display unless otherwise indicated on the drawings.
3. The flow meter must be rated for a minimum of 150% of the design water flow gpm.

D. GAUGE PANEL

1. Refer to the Drawings for a representation of the pump gauge panel.
2. Vacuum, pressure, flow, and temperature gauges must be mounted on the panel using back-connected gauges.
3. Materials:
 - a. PVC
 - b. Stainless steel

E. PRESSURE GAUGES

1. Provide primary recirculation pumps with a pressure gauge with sensor tubing installed on the pump's discharge side, as shown in the Drawings.
2. Each pressure filter/strainer system must have two pressure gauges, one mounted on the influent-side and one on the filter's effluent side.
3. The gauge can read a maximum pressure of 50-psi [344.7 kPa].

4. The gauge must be fitted with a 0.25-inch [6 mm] NPT stem back connection and be suited for direct back-mounting on the gauge-panel.

F. PRESSURE REDUCING DEVICES

1. Pressure-reducing valves: Bronze, rated for a maximum supply pressure of 300-psi [2,068.4 kPa], and adjustable downstream pressure of 25 to 75 psi [172.4 to 517.1 kPa].
2. The unit must be factory-preset at 65-psi [448.2 kPa].
3. The Basis of Design: Watts's #LF25AUB-Z3 sized to match the incoming municipal water supply pipe size by Watts Water Technologies Company; Lawrence, MA 01842; 617.688.1811.

G. PRESSURE RELIEF VALVES

1. Material: Bronze, rated for an AGA/CGA steam rating of up to 14,370,000 BTU/hour (or specified by the specific manufacturer's requirements).
2. The valve must be set to relieve at a temperature of 210° F [98° C] and a pressure of 125 psi [861.8 kPa].
3. Inlet and outlet connections must be up to 2-inches [50 mm] NPT.
4. Unless otherwise specified, pressure relief valves for ratings not exceeding 14,370,000 BTU/hour must be Watts's #174A.
5. The balance of the specified pressure relief valves must be sized per the manufacturer's requirements.
6. Pressure relief valves must be by Watts Water Technologies Company; Lawrence, MA 01842; [617.688.1811].

H. TEMPERATURE GAUGES

1. Each heated system must be provided with a remote-reading temperature gauge (or thermometer) with the sensor connected to the downstream side of the mixed, heated water piping run.
2. The temperature gauge can read a maximum temperature of 120° F [48° C].
3. Wetted materials must be of stainless steel, Type 316L.
4. Gauges must be remote back-mounted onto the pump gauge panel.
 - a. Aluminum

I. VACUUM GAUGES

1. Provide primary recirculation pumps with a vacuum gauge with sensor tubing installed on the pump's suction side, as shown in the Drawings.
2. A vacuum gauge can read a maximum vacuum of 15-inches [380 mm] Hg.
 - a. The vacuum gauge must be fitted with a 0.25-inch [6 mm] NPT stem back connection and be suited for direct mounting on the pump inlet pipe.

J. WATER HAMMER ARRESTORS

1. Provide in strict conformance with the manufacturer's recommendations.
2. The Basis of Design: Watts Model "1 LF15M2-FS Unit Size F" by Watts Water Technologies Company; Lawrence, MA 01842; 617.688.1811. Note: The Model number may vary depending on the size.

K. WATER LEVEL CONTROLS AND WATER FILL SYSTEM

1. Provide a water-level sensors system and related water level control panel into each Water Feature as indicated in the Drawings. Pre-approved equals may be accepted.
 - a. Each device must provide sensing signals to activate a relay and solenoid valve located in the mechanical equipment room.
 - b. The sensor units operate at 12-24VDC < 2 Amps.
 - c. The same manufacturer must fabricate the level sensor, level fill controls, and fill valving manifold.
2. The sensor may be a single unit with different outputs that correspond to different water levels or a set of discrete sensors placed at the water levels of interest. Refer to the Drawings and Equipment Schedule.
3. The Water Level Control Panel must be those specified in the Equipment Schedule.
4. The Water Level Control Panel must typically monitor the water level at three setpoints, listed from highest to lowest:
 - a. High-High setpoint – when the water level is below this elevation for a minute or more, all pumps are off, and the fill valve is opened for a short period.
 - b. High setpoint – when the pumps are on and the water level is below this elevation for longer than a minute, the fill valve is opened until this setpoint senses that the water elevation is above it for longer than a minute. If a static line is available, a single sensor installed on that line may turn the fill valve on and off, regardless of if the pumps are on and off, and this may replace the High and High-High sensor described here.
 - c. Low setpoint: When the water level is below this elevation for longer than a minute, and the fill-valve is presumably already in an open position, all pumps and underwater lights must be de-activated (shut down) to prevent their operation and damage when operating without sufficient water being present.
 - 1) If there is a dynamic draw-down on the tank, the water level must increase after deactivating the pumps. For this reason, this low setpoint sensor cannot be used to re-activate the operation of the pumps and lights.
 - 2) Instead, the pumps and lights are permitted to re-activate their operation when the water elevation is located above all designated setpoints for longer than one minute.
 - d. Refer to the Drawings for additional level set-points required.

L. INDUSTRIAL LIQUID FLOW SWITCH (OPTIONAL)

1. Operation: This control-operation is an independently mounted water flow sensing device that breaks an electrical circuit when the water flow stops or starts.
2. Electrical enclosure rating:
 - a. NEMA X for outdoor
 - b. NEMA 1 for indoor (totally enclosed with no corrosive fumes)
3. Maximum Velocity: 10-feet/sec [3M/sec]
4. Pipe connection size: 1.25-inches [30 mm] NPT
5. The Basis of Design:

- a. McDonnell & Miller (an ITT company), 8200 N. Austin Ave., Morton Grove, IL 60053, www.mcdonnellmiller.com
 - 1) Model FS7-4 for pipe sizes: 1.5-inches to 16-inches [40 mm to 400 mm]
 - 2) Model FS7-4L for pipe sizes: 20-inches to 36-inches [500 mm to 900 mm]

M. PRESSURE TRANSDUCER (OPTIONAL)

1. Provide a measurement of influent/ effluent filter system pressures utilizing transducers.
 - a. The transducers may have an operating range from 0 to 20 psi [0 to 137.9 kPa] through 0 to 100 psi [0 to 689.5 kPa] with an output of 4 to 20 mA. The transducers must have a $\pm 2\%$ span max @ 77° F [25° C], which includes linearity, hysteresis, and repeatability, 0.25% static error band, and 1.5% typical thermal error band.
 - b. The transducer's wetted components must be stainless steel with plumbing connections of 0.125-inch [3 mm].
2. Vacuum Transducer:
 - a. Provide a measurement of recirculation pump vacuum utilizing a transducer.
 - b. The transducer must have an operating range of 0 to 30-inches/Hg. [0 to 762 mm/Hg.] with an output of 4 to 20 mA. The transducers must have a $\pm 2\%$ span/ year typical long-term drift, 0.25% static error-band, and 1.5% typical thermal error-band.
 - c. The transducer's wetted components must be stainless steel with plumbing connections of 0.25-inch [6 mm].

N. LIQUID LEVEL SENSOR

1. The level sensor must be constructed of noncorroding material and must provide at least two programmable relay outputs and a single 4 to 20 mA output.
2. The sensor must be field-calibratable, allowing for site modifications within an operating range from 1 to 9 feet [0.3 to 2.75 m].

O. AUTOMATIC ELECTRONIC MODULATING VALVE CONTROL (REQUIRED WHEN THE MAIN DRAIN CONNECTS TO A SURGE TANK)

1. Minimum components:
 - a. Normally closed, pneumatically actuated Butterfly Valve on main drain line(s) with spring return
 - 1) Basis of Design for Butterfly Valve: Bray Series 30/31
 - 2) Basis of Design for actuator: Bray Series 92/93
 - b. Pneumatically powered positioner with 4-20mA input
 - 1) Basis of Design: Bray 6A
 - c. Tank level sensor with 4-20 mA output
 - d. PID control circuitry or software, with all three parameters (P, I, and D) user-selectable, takes the signal from a tank level sensor and a create signal for the valve positioner. The PID unit may be a stand-alone device or part of any control panels or PLC's described elsewhere in these Specifications.

1) Basis of Design: Koyo DL05 PLC

2.15 CHEMICAL

A. GENERAL

1. Chemical controllers, chemical feeders, and related chemical pumps must meet the requirements and carry the product certifications for NSF Standard 50.
2. Only NSF-60 approved chemicals must be provided.
3. Critical:
 - a. The use of Sulphuric Acid is prohibited.
 - b. The use of chlorine sticks/tablets containing chlorinated isocyanurates (stabilized chlorine or cyanuric acid) is prohibited.
 - c. The use of chlorine gas is prohibited.
4. Erosion-type and water-spray-type chlorine feeders must incorporate an integral flowmeter and a flow-adjustment valve.
5. Each pool must be equipped with an operational pH adjustment feeder with automated controls for precise attainment of the pool water's targeted pH levels.
6. Automated Oxidation Reduction Potential (ORP) & PH controllers must be provided for all pools and basins intended for human use.
7. UV, chemical controllers, chemical metering pumps, saline chlorination, CO2 gas feed, erosion and spray chlorine feeder systems, & all equipment, electrical components, and wiring must comply with the requirements of the National Electrical Code, and the manufacturer must provide a certification of the conformance to the jurisdiction building department

B. CHEMICAL CONTROLLERS

1. General
 - a. The integrated equipment room control system must provide continuous monitoring and command of sanitizers (standard ORP probe or the Cl/Br amperometric probe), oxidizers, pH, temperature, system flow rate monitoring for each return line, flow rate monitoring for the heater piping, chemical inventory levels, surge tank water levels, MFV control, system pressures, and water chemistry balance calculations.
 - b. The Basis of Design: BECSys5 by BECS Technology. Manufacturer Representative: CES, 2 Jupiter Park Lane, Suite 1, Jupiter, FL 33458, USA; 800.940.1557;
WWW.CESWaterQuality.com
2. Controller
 - a. The controller must have 120 VAC; <1A fused input must come in a NEMA 4X enclosure.
 - b. The controller must allow assignment of primary alarm, equipment room control, and be equipped as follows:
 - 1) Power outlet for the oxidizer (typically Chlorine) feed
 - 2) Power outlet for the pH feed
 - 3) Input to read filter pump status
 - 4) Additional inputs/outputs required for the surge, collector, and reservoir tank water levels are required.

- a) Tank level sensing to automatically adjust the variable opening/closing of the solenoid valves at the tanks – rapid valve closure rate is mandatory
 - b) Tank level sensing determines low water levels and transmits a signal to deactivate all pumps related to a specific tank's operation.
 - c. The controller must carry UL 508, (CSA) C22.2 Number 205- M1983, FCC part 15 subpart B product certifications.
 - d. Water Chemistry Control
 - 1) Continuously monitor and power pH, ORP, & Cl/Br ppm
 - a) Selectable control of sanitizer through ORP or amperometric ppm
 - 2) Selectable on/off feed or time-based proportional feed
 - a) Time-based proportional feed cycle time may vary based upon the variance of measurement to setpoint
 - b) Proportional-band of 0 to 2.0 pH units, 0 to 100 mV, 0 to 2 ppm [0 to 2 mg/L] with an increased offset from setpoint causing increased feed system operation
 - c) Regulate the-output of the chemical feed system from 10% to 100% of capacity
 - d) Sanitizer min/max residual selectable for non-primary control method (i.e., ORP control can have min/ max amperometric ppm value)
 - 3) The feed duration alarm circuit must disable appropriate feed and activate an alarm circuit
 - a) Sensor failure
 - b) Chemical feed malfunction
 - c) Low chemical feed inventory
 - d) Overfeed time (programmable from 0 through to 18 hrs., 1-minute resolution)
 - e. Liquid Level Alarms
 - 1) Surge tank low-level setpoint to disable recirculation pump and all pumps related to the specific tank – coordination with the contractor's Control Panel must occur
 - 2) Surge tank low-level setpoint to initiate autofill solenoid
 - 3) Surge tank level sensing to adjust the variable (fast-acting) floor drainpipe solenoid valves (4-20 ma technology)
 - 4) pH chemical inventory low-level setpoint
 - 5) Sanitizer chemical inventory low-level setpoint
3. Control Displays
- a. The display must be backlit LCD with a minimum resolution of 12x40 alpha/numeric, graphical characters that are capable of displaying the following:
 - 1) pH: 0.0 to 14.0 with a 0.1 or 0.01 resolution (programmable)
 - 2) ORP: of -1000 to 1000 mV, 1 mV resolution
 - 3) PPM's: 0 to 20 ppm [0 to 20 mg/L] 0.1 or 0.01 resolution (programmable)
 - 4) Temperature: 32-212°F, 1°F resolution; 0-100°C, 1°C resolution
 - 5) Flow rate: 0-8800 gpm, 0.1 gpm resolution; 0-33265 liter/min, 0.between1-liter resolution

- 6) Flow volume: 999 trillion gallons, 1-gallon resolution; 999 trillion liters, 1-liter resolution
 - 7) Pressure: programmable range psi, kPa
 - 8) Vacuum: 0 to 31 inches/ Hg, 0 to 787 mm/ Hg
 - 9) Surge tank: programmable range 0.01-feet, 0.01 m
 - 10) Chemical Inventory: programmable range 0.1-feet, 0.1 m
 - 11) Heater setpoint & alternate heater setpoint (4 Event 28-day timer)
 - 12) Alternate ORP control setpoint (4 Event 28-day timer)
 - 13) Cl/ Br booster ORP or ppm feed points with separate trigger setpoints
 - 14) Superchlorination ORP or ppm setpoint
 - 15) Display of Ca hardness & alkalinity
 - 16) Langelier & Ryznar index calculated
 - 17) Smart menus w/ integrated help
4. Feed Mode:
 - a. Auto/ manual off/manual-on, which must provide on/off or proportional feed modes.
 5. Data Logging - The controller must have battery-backed RAM or flash memory for input level recording and events.
 - a. Thirteen input level recordings for 19 to 56 days, depending on the sample rate (2 to 6 minutes):
 - 1) pH, ORP, ppm, temperature, & TDS
 - 2) Flow Rate, pressure differential & strainer vacuum
 - 3) Surge tank level
 - 4) Two chemical inventory levels
 - b. 3800 events over a maximum of 21 days recording alarms, menu changes, and operational cycles related to the following parameters:
 - 1) pH, ORP & ppm Hi/ Low w/ interlocked failsafe
 - 2) Water temperature
 - 3) System Low-flow & sample stream No-flow
 - 4) Pressure differential & vacuum Hi
 - 5) Surge tank water level: Low
 - 6) Autofill
 - 7) Chemical Inventory: Low
 - 8) Battery: Low
 6. Safety Systems
 - a. The controller must have at least three security password levels, with six for operators, two for managers, and one for the distributor providing a history of access identified by the user.
 - b. The controller must also have programmable alarms (some disabling chemical feed) for pH, ORP, free chlorine ppm, temperature, low flow & no flow, chemical overfeeds, pressure & vacuum, and surge levels chemical inventory, backwash initiation & cycle duration.

- c. Alarm conditions must activate a primary alarm signal provided as a dry contact relay enabling 0-240 VAC alarms.
- 7. Alarm Indicators:
 - a. Flashing LED alarm indicator with an auto-polling LCD of hi / low out of range, overfeed, low system flow, and sample stream no flow
- 8. Remote Operation
 - a. The controller must be provided with a means to connect to the Internet.
 - b. Provide remote operation software with a graphical display for interactive connection and direct connect capability to a PC with the controller. Operational data logs, graphs, and event calendars must be included with the software.
- 9. Sensors
 - a. The controller must have four (4) standard sensors and seven (7) additional sensors. Although some sensors are listed as “additional” by the manufacturer, they are specified for this project and must be provided by the installer for all pools.
 - b. Standard Sensors:
 - 1) The standard pH and ORP sensors must come with a Ryton body and inorganic electrolyte gel.
 - 2) Flow Sensor: Provide a measurement of pool circulation flow rate utilizing a self-powered 4-20 ma paddle-wheel flow-sensor equipped with a minimum of 25-feet [7.5 m] cable and saddle.
 - 3) Amperometric Sensor
 - a) The Free Chlorine Sensor must be an amperometric probe system with a measuring range of 0.05 to 20 ppm [0.05 to 20 mg/L] with an entirely selectable scale and temperature range of 36°-113° F [2°-45° C].
 - b) The amperometric probe must come with a PVC body, replaceable PTFE membrane and electrolyte, gold cathode, and silver/ silver chloride anode.
- 10. Flowcell:
 - a. Include a clear viewing tube.
 - b. Provide hydro-mechanical cleaning of the free chlorine sensor.
 - c. Provided all required isolation and wet-test valves
- C. PERISTALTIC CHEMICAL METERING PUMP FOR LIQUID CHLORINE OR MURIATIC ACID
 - 1. Provide a self-priming, positive displacement, metering-pump rated for suction lifts of 25-feet [7.62 m]
 - 2. The metering pump must have a roller that presses against a peristaltic tube capable of feeding chemicals against a 25 psi [172.4 kPa] upstream fluid.
 - a. The peristaltic tubing must be capable of easy replacement. The dis-assembly of the 3-head roller must be removable without tools.
 - 3. The rotation rate must be capable of varying, adjustable output flows from 5% to 100% (with 2.5% increments) of its rated gpm output.
 - 4. The motor drive can operate in temperatures up to 125° F [51° C] with a maximum draw of 1.7 amps and rated for a continuous duty cycle.

5. The pump must wall-mount and be equipped with 6-feet [1.83 m] length 120 vac electrical cord and appropriate electrical plug.
6. The Basis of Design (models as listed in the Equipment Schedule): Stenner Pump Company, 3174 DeSalvo Road, Jacksonville, FL 32246, 904.641.1666; Manufacturer Representative: CES, 2 Jupiter Park Lane, Suite 1, Jupiter, FL 33458, USA; 800.940.1557; WWW.CESWaterQuality.com
7. Chemical supply: The Contractor must provide the liquid chlorine or muriatic acid to fill the separate tanks for the commissioning and initial service period. Upon receipt of the substantial completion certificate from This Engineer, the Contractor must refill the liquid chlorine tank and the muriatic acid tank to capacity. These chemicals must not be mixed.

D. ULTRAVIOLET DISINFECTION EQUIPMENT

1. General:
 - a. Ultraviolet Disinfection Equipment shall operate within the UVC electromagnetic spectrum emitting wavelengths in the range of 200nm to 400nm. These required wavelengths shall provide constant disinfection/inactivation of bacteria, algae, molds, viruses, and destruction of Monochloramines, Trichloramines, and Dichloramines. Ultraviolet Lamp/Chamber and Spectra Control Panel by Evoqua Water Technologies Ltd. Any deviation/exception must be provided in writing to and approved by the designer before the bid date.
 - b. The UV Equipment shall have a MET or equivalent (ETL, CSA, or UL) listing, be NSF-50 2016 certified, and 3rd party validated to the USEPA UVDGM 2006 Guidelines.
 - c. Equipment General Description
 - 1) The Ultraviolet Equipment shall be provided in a complete package to include a Stainless-Steel Chamber, Spectra Control System located in a NEMA 12 (IP52) rated panel, Medium Pressure Bulb(s) designed to emit wavelengths within the UVC electromagnetic spectrum, automatic wiper system, and Project Commissioning by a Certified Ultraviolet Technician.
 - 2) The Ultraviolet System (UV) must be provided to include a chamber, control system, Medium pressure bulb(s) designed to emit specialty-wavelengths within the UVC electromagnetic spectrum, strainer basket automatic wiper system, and project commissioning by a local Technician certified by the Manufacturer.
 - 3) Must operate within the UVC electromagnetic spectrum emitting wavelengths in the range of 200nm to 400nm.
 - d. Unit Description: Wafer (WF) Units
 - 1) The ultraviolet manufacturer offers the unit capability of a horizontal OR vertical installation application using state of the art design and direct flow-through characteristics. The unit must be a medium pressure system with a US GPM flow rating @ 94% UVT. Any systems validated or designed for flows based on 98% UVT are not acceptable. Chamber and Control Cabinet shall be as indicated on the drawings.

- e. UV equipment must meet UL standards and must be electronically interlocked with recirculation pump(s) on all pools and with feature pump(s) on an IWF such that when the UV equipment fails to produce the required dosage as measured by an automated sensor, the feature pump(s) are disabled, so the water feature systems do not operate.

2. ULTRAVIOLET CHAMBER

- a. Pressure rated for 100 psi (with a factory-test to 150 psi), and minimal pressure drop across the unit. Construct the unit of 316L stainless steel passivated to assist in preventing corrosion. The Ultraviolet chamber must come intact with the following equipment:
 - 1) Ultraviolet intensity-monitor must be factory calibrated to provide intensity in mw/cm² monitors offering a percentage of lamp output that is not acceptable. Include a built-in alarm system to notify the operator when the output level drops below 60 mj/cm² for indoor-pools or 40mj/cm² for outdoor pools. Dosing levels to be adjustable by Operator.
 - 2) Provide an ultraviolet temperature control system to maintain system integrity in flow interruptions to the chamber. Include the following:
 - a) Annealed quartz-sleeve with "O" ring-seals for water tightness.
 - b) ANSI (American National Standards Institute) flanges and ports or vents must be threaded NPT (National Pipe Thread). The Ultraviolet-chamber must be capable of installation within the circulation system to remain unrestricted with no air allowed.

3. ULTRAVIOLET LAMP

- a. The ultraviolet lamp must be medium pressure high intensity. The lamp must be designed to emit continuous Ultraviolet wavelengths in the range of 200nm to 400nm, providing optimal disinfection benefits and destruction of the Monochloramine, Dichloramine, and Trichloramine compounds. The lamp must remain unaffected by temperature variance of 0 degrees to 200 degrees F.
- b. The lamp-system must provide a constant dose of not less than 60 mj/cm² until the end of the lamp-life for indoor applications and not less than 40 mj/cm² for outdoor disinfection, continually monitoring the full recirculating flow rate, not on a side stream treatment. Power stepping systems are not acceptable.

4. AUTOMATIC WIPER SYSTEM

- a. Provide an automatic cleaning system for cleaning the quartz sleeve and Ultraviolet monitor probe

5. ULTRAVIOLET CONTROL SYSTEM

- a. Systems must be epoxy coated NEMA 12 rated cabinet. If mounted outdoors, they must be NEMA 4X with an integral A/C unit to protect the components from the environment.
- b. Provide three levels of operation:
 - 1) Simple control (start, stop, and reset)
 - 2) Complete parameter display
 - 3) Customized operator configuration

- 4) Modes of operation must be password protected to secure system critical setup functions. A Touch Control system must have identifiable start, stop, and reset icons (suitable for gloved operation) with running and fault LCD indicators.
 - c. The touchscreen must display a minimum of the following:
 - 1) Ultraviolet dose values (derived from flow and intensity inputs)
 - 2) Ultraviolet intensity (as a % and mw/cm²)
 - 3) Lamp current
 - 4) Flow rate (accepts a signal from optional flow meter – displayed as gallons per minute)
 - 5) Chamber temperature (displayed as degree F)
 - 6) Operation hour meter
 - 7) Lamp fault
 - 8) Low Ultraviolet & temperature alarm
 - 9) Ground fault trip
 - 10) Alarm functions must have a simple text message display to assist in fault finding.
 - d. The Touch Control system must have, at a minimum, the following system interface control:
 - 1) Remote operation
 - 2) Low UV dose (configurable to shut down or alarm only)
 - 3) Flowmeter input
 - 4) Auto-Restrike
 - 5) 50% - 100% power Ultraviolet setting with 24 hours/7-day settable timer
 - 6) Dose-pacing interface.
 - e. Built-in data-logging capabilities to record the following information:
 - 1) Ultraviolet intensity specified
 - 2) Ultraviolet intensity measured
 - 3) Lamp current
 - 4) Chamber temperature
 - 5) Flow rate (if the flow meter is connected)
 - 6) Time and date stamp, with alarms generated.
 - f. The system must be interfaced with a chemistry controller that can measure total or combined chloramines to maintain the proper dosage specified during the lamp's life.
 - g. Capable of operating through Ethernet or Wi-Fi.
 - h. Capable of interfacing with a SCADA-system, including both Profibus and Modbus.
- E. SALINE CHLORINATION SYSTEM**
1. General
 - a. Chemical sanitizer for the pool(s) must be sodium hypochlorite generated on-site in offline installation.
 - b. The chlorine generator system must be NSF-50 listed and UL-1081 listed and certified for pools and spas.

- c. The electrical wiring, circuit-breakers, and disconnect boxes provided at the facility must be UL listed components.
 - 1) The system must be pre-wired, ready for field connection of power interconnected to the pool pump and control circuits.
 - 2) All equipment and power supply must be bonded/grounded via the bond/ground UL-Listed lug to the local shared-bonding/grounding grid. The bonding/grounding connector lug must connect conductively with the bonding/grounding means.
- d. The system can operate in water temperatures ranging from 59-deg F [15-deg C] to 104-deg F [40-deg C].
- e. The system must have salt concentration displayed in PPM, measured using a toroidal probe. No moving parts and no calibration needed.
- f. All pools specified with a saline chlorine generator must be provided with a sodium chloride test kit without exception.
- g. An authorized representative must be located within a reasonable distance of the facility and must be available to install and service the systems as required.

2. Salt Chlorine Generators

- a. The SM system must produce the specified amount of equivalent chlorine as a dilute solution of sodium hypochlorite from a single cell, plumbed in bypass, from a saline concentration of 3,500 – 7,000 ppm in the pool water, or a separate salt feeder.
- b. Chlorine delivery must be controlled by a bypass side stream, plumbed into the return line using a bypass valve, and providing the saline system with a minimum of 20 gpm.
- c. The chlorine generator must not require a water softener.
- d. Chlorine delivery to the pool recirculation is controlled by an electrical diaphragm metering pump or venture distribution system.
- e. Flow-through the ChlorKing® NEX-GEN cell is adjustable to meet production requirements. Flow switches are included as safety devices.
- f. The system must include a hydrogen dilution blower to remove hydrogen from the production tank safely.
 - 1) Hydrogen must be vented from the production tank using the supplied ventilation port on the top of the production tank at field installation.
 - 2) The system may not allow chlorine production if the hydrogen dilution blower is not active and no air movement is detected.
- g. The Basis of Design: Manufacturer: ChlorKing®, www.chlorking.com; Manufacturer Representative: CES, 2 Jupiter Park Lane, Suite 1, Jupiter, FL 33458, USA; 800.940.1557; 800.536.8180 WWW.CESWaterQuality.com

F. SPRAY TECHNOLOGY CHLORINATION SYSTEMS – PULSAR

1. Pulsar Chemical System – Precision

- a. The system design must use an NSF Standard 50 listed feeder and tablet combination and meet the Health Department requirements with authority over the installation.
- b. The Sanitization System must incorporate the principles of spray technology.
 - 1) Water must spray on to the Briquette Tank layers, contacting Pulsar® Plus Dry Chlorinator Briquettes.

- 2) The briquettes may contact the water quickly, creating a chlorinated solution falling into the discharge tank.
 - 3) The Briquette Tank may have a capacity of three hundred (300) pounds of Pulsar® Plus Dry Chlorinator Briquettes.
 - c. The chlorinated solution may be drawn by the vacuum from the discharge tank and introduce into the recirculation system.
 - 1) The output must operate within a vacuum range between 5" and 29" Hg.
 - d. The vacuum is created by the Mazzei venturi, model 1585X, which is installed in the post-filter recirculation loop driven by a 1hp Pulsar® booster pump.
 - e. The venturi must be installed on the Pulsar® pump's discharge side, creating a flow through the venturi, which provides suction on the discharge valve evacuating the discharge tank.
 - f. An emergency overflow switch must ensure that the spray manifold's water flow is shut off in the unusual event that the discharge tank(s) may not have appropriately emptied.
2. The Pulsar Precision System operates with an inlet water pressure of 25-45 psig. The inlet water is supplied from the integral 1hp Pulsar® pump provided by the Pulsar Manufacturer.
 - a. An ORP controller must control the chlorine-output.
 - b. The Sanitization System must be incapable of functioning within temperatures between 40° F. and 115° F.
 - c. The Sanitization System must operate with the Pulsar® Plus Dry Chlorinator Briquettes having 65% minimum available chlorine with a 0.4 to 1.0% scale inhibitor (by weight).
 3. Manufacturer Representative: CES, 2 Jupiter Park Lane, Suite 1, Jupiter, FL 33458, USA; 800.940.1557; WWW.CESWaterQuality.com

G. CHEMICAL TUBING

1. Chemical tubing suitability must be rated as "GOOD" (or better) as it pertains to its rating a chemical compatibility rating chart suitability for accommodating any specific chemical required.
2. The chemical tubing diameter must be no less than 0.375-inch [10mm] or as required by the chemical feeder manufacturer.
3. Outdoor-located (or exposed to UV rays) tubing must be rated as "UV black suction/discharge chemical tubing;" pressure rated at 45 PSI @ 73-deg F.
 - a. Exception: When used indoors and not exposed to any UV, Tygon B-44-3 model AAB00029 tubing may be used.
4. The following chart must be used as a guide in selecting chemical tubing:

Chemical Required	Recommended Tubing Material at 70° F [21° C]	UV Properties (when exposed to UV or located outdoors)
Muriatic Acid	Tygon Chemical®; Viton®; Teflon® PTFE	UV Black

(maximum: 20 percent Baume° (a 31.45% diluted form of Hydrochloric Acid)		
Sodium Hypochlorite, >5%	Silicone; Tygon Chemical®; Viton®; Teflon® PTFE	UV Black

5. The Basis of Design: Tygon UV Resistant R-3400 model # AAE00029; Saint-Gobain Performance Plastics; 2664 Gilchrist Road, Akron, OH 44305; 800.798.1554; www.tygon.com

2.16 HEATERS

A. COMMERCIAL POOL HEATER

1. Gas-fired heaters must be provided for each pool per the schedule in the Drawings.
2. The Basis of Design:
 - a. Materials used in heaters are non-toxic and acceptable for potable water use.
 - b. A fixed thermometer is mounted in the pool recirculation line downstream of the heater outlet line connection when a heater is provided. Note: Thermometers mounted on heater outlets do not meet this requirement.
 - c. Smaller commercial pools and spas: "ERN" high-efficiency natural gas-fired heater by Lochinvar
 - d. High-water-flow for large commercial pools: Copper-Fin II natural-gas heater by Lochinvar.
 - 1) Provide orifice for natural gas or propane pending fuel available at the Site. The heater manufacturer must provide the gas orifices, pressure, and components required for Natural Gas or propane operation, as noted.
 - e. Manufacturer Representative: CES, 2 Jupiter Park Lane, Suite 1, Jupiter, FL 33458, USA; 800.940.1557; WWW.CESWaterQuality.com
3. Refer to model numbers indicated on the Drawings and Equipment Schedules. Each heater provided must incorporate the designation of "ASME" certified within the model number/name.
4. Provide heater systems using Electronic Ignition Systems. Continuously burning pilot light systems are expressly prohibited.
5. Performance: The heater(s) must be rated, as shown in the Drawings. Supply the following minimum equipment components & items with each heater:
 - a. Heater assembly must be certified by the American Gas Association (AGA).
 - b. Water Containing and Heat Exchanger Section: The water containing section must include Cupro-Nickel Tubes having extruded integral fins. The tubes must terminate into a one-piece lined, Cupro-Nickel Heat Exchanger.
 - c. There must be no bolts, gaskets, or "O" rings in the head configuration.
 - d. Provide the mounting of the Cupro-Nickel heat exchanger in a stress-free jacket assembly providing a "free-floating design" capable of withstanding the effects of thermal shock. The Pool Heater must bear the ASME (American Society of Mechanical Engineers) "H" stamp for 160 psi [1,103.1 kPa] working pressure and must be National Board listed.

- e. The heat exchanger assembly must carry a five (5) year warranty.
- f. The combustion chamber must be sealed and wholly enclosed with ceramic fiberboard insulation. The pool heater must have an integral combustion air blower to govern the fuel/air mixture.
- g. The heater must be furnished with a factory-supplied pumped bypass assembly to confirm proper operation without condensation. The bypass assembly must include a sealed bronze or stainless-steel pump suitable for outdoor installation. The bypass assembly must be constructed of schedule 80 CPVC piping with brass inserts, an automatic three-way valve, and a proportional flow valve to bypass water to the pool vs. the heater.
- h. Enclosure: Pool heater enclosure must be suitable for outdoor installation.
- i. Certifications and Operating Efficiency: The pool heater must be certified and listed by The American Gas Association under the latest edition of the appropriate ANSI test standard.
- j. The pool heater must comply with the energy efficiency requirements of the most recent edition of ASHRAE 90.1 Standard and operate at a thermal efficiency of at least 85 percent.
- k. Controls: Standard operating controls & minimum internal features must include:
 - 1) ASME temperature, pressure relief valve, flow switch, & lubricated gas plug cock
 - 2) Auxiliary heater limits-control is factory-installed in a weatherproof enclosure.
 - 3) Blocked flue pressure switch
 - 4) The built-in low gas pressure regulator
 - 5) Combination of low air and blocked flue pressure switch to monitor fan operation
 - 6) The control panel must have a primary switch with an indicating light and sequential and diagnostic indicator lights.
 - 7) Data Log to include a: Hours Running; b: Ignition Attempts, and c: Last 10 Lockouts
 - 8) Factory-installed flow sensor switches for low water flow sensing to de-activate the heater
 - 9) High Voltage terminal strip with 120 VAC / 60 Hertz / 1-phase power supply and pump contacts with the pump relay
 - 10) Ignition system with a full flame monitoring capability.
 - 11) Low air pressure switch for each fan
 - 12) The manufacturer's factory-testing protocol includes: Verify proper operation of the burners, all controls, and the heat exchanger by connection to water/venting for a factory fire test before shipping. A quality test report must be shipped with each unit. Incorporate the following critical sub-systems:
 - a) Multiple main gas-valves with redundant valve seats and built-in low gas pressure regulators.
 - b) All pool safety high limit, manual reset high limit control, and auxiliary heater high limit control.
 - c) All redundant proven Ignition systems with full flame monitoring capability. Each Ignition system must be able to function independently in the event of a failure in one system.

13) Operating Controls to include minimum 2-Line/16 Character LCD Display, Cascading Sequencer for two or three heaters, c: Password Security, d: Low Water Flow Control & Indication, e: Inlet & Outlet Temperature Readout (with a +/- 1-deg F accuracy), f: Freeze Protection, g: Service Reminder, h: Time Clock.

14) Time-switches for compliance with energy conservation codes

15) Water pressure switch

l. Venting: The heater must be approved for indoor or outdoor installation. Venting must be classified as Category I, negative draft, noncondensing, and type "B" double wall venting materials. Direct Vent installations (Category IV) require the use of AL29-4C venting materials.

m. If the heater is mounted outdoors (refer to the Drawings), extend flues, heater ducting, vents, and power fans as specified by the Heater Manufacturer to prevent drafting conditions and comply with local and state codes.

n. Exhaust: The pool heater must have an independent laboratory rating for Oxides of Nitrogen (NOX) of 9.9 ppm corrected to 3 percent O².

B. DUCTING, EXHAUST, AND FLUES ASSEMBLIES/SYSTEMS

1. General:

a. Ducting, flues, piping, and vents must comply with the gas heaters' manufacturer's requirements.

2. As a minimum, the design intent is for Category I negative draft, noncondensing, and include only Vent Type B galvanized steel, double-wall vent, ducts, flues, and piping.

a. Provide a Tee and Barometric exhaust relief damper per the manufacturer's requirements.

3. For Category "III, IV" configuration (not utilizing a fan at the point of termination), the ducting must be stainless positive pressure vent material and used with associated vent kit accessories per the manufacturer.

4. The Basis of Design: Refer to the Designated Specialty Engineer's documents.

a. These are Complete Build activities. Refer to COMPLETE BUILD SCENARIO OVERVIEW

C. PLATE HEAT EXCHANGERS

1. Pool Temperature Control & Heat Transfer Skid:

a. Materials:

- | | |
|-------------------------|---|
| 1) Plates: | Titanium - no exceptions. |
| 2) Fixed Cover: | Carbon Steel with an Epoxy fused coating |
| 3) Movable Cover: | Carbon Steel with an Epoxy fused coating |
| 4) Carrying Bars: | 316 stainless steel |
| 5) Nozzles – Hot Side: | Studded Titanium |
| 6) Nozzles – Cold Side: | Studded Titanium |
| 7) Gaskets: | FDA – EPDM |
| 8) Bolting: | 316 stainless steel |
| 9) Shroud: | Galvanized steel (except outdoor located PHE must have aluminum or SST shroud). |

- b. Each pool must be heated with a pre-plumbed heat transfer skid configured with a titanium plate and frame heat exchanger tied into the primary heating loop.
 - 1) Coordinate the plate size with performance requirements.
 - c. Individual heat transfer skid packages must be pre-plumbed with the maximum allowable pressure drop to exceed the ΔP explicitly authorized by the Project's Plumbing (MEP) Engineer. PHE (Plate Heat Exchangers) flows each dependent on the primary loop pump to provide the ADE-specified design flows.
 - d. Individual pool plate exchanger performance is based on ADE BTU loading analysis, 82°F [29.4°C] pool design, 104°F [40°C] spa design, and the hot water supply and maximum allowable pressure drop for pool and hot water sides of PHE as specified explicitly by the Project's Plumbing Engineer.
 - 1) Unless others are noted herein, each PHE must also be sized to perform chilling in the pool water. Size the PHE to provide 82-deg F. [26.6-deg C.] water in an uncovered pool surface area.
2. Pool Temperature and Safety Control:
- a. Pool water flow rates and the water (from the transfer skid) must be monitored and controlled to prevent excessive water temperatures. The PID (proportional-integral-derivative) controller must provide the following command functions.
 - 1) Monitor and maintain pool temperature accuracy to +/- 0.25°F
 - 2) Verify minimum pool water flow required to prevent overheating PVC pipes
 - 3) The positioning of the hot water flow control valve for adjusting variable HW flow to PHE via a proportionally controlled butterfly valve
 - 4) Provide high-temperature limit flow control shut down with an actuated butterfly valve on hot water supply. Spring return to closed if pneumatic operated, battery backup if electrically operated.
3. Heat Transfer Skid Components:
- a. Each heat transfer skid must include the following elements:
 - 1) Corrosion-resistant skid and framing
 - 2) PID Controller in NEMA 4X enclosure
 - 3) Flow metering device for minimum flow control for pool water or Flow switch device for minimum flow control to prevent pool water overheating
 - 4) CPVC piping, fittings, flanges, isolation valves with 316L stainless steel hardware
 - 5) Inlet and outlet pressure gauges and dial thermometers
 - 6) Pre-plumbed and leak-tested, factory wired with documented continuity tests
 - 7) Factory start-up and field programming to meet performance requirements
4. Certifications and Testing:
- a. Rated Design Pressure: 150 PSI [1,034 kPa].
 - b. The manufacturer/fabricator must hydro-test the unit to a minimum of 1.3 times the design pressure per ASME Code.
 - c. The manufactured / fabricated unit must be certified as ASME Approved / Rated
 - d. Design & construction to be compliant with ASME Section VIII, Division 1
 - e. Basis of Design: Plate Heat Exchangers by Delta Hydronics, 1011 East Lemon Street, Tarpon Springs, Florida 34689, (727) 938-2421, Website: www.deltahydro.com

5. POOL-SIDE TEMPERATURE CONTROLLER

- a. The controller must automatically control solenoid valves' operation, maintaining a pre-set water temperature ranging from 70°F to 104°F.
- b. Assembly must be UL Listed
- c. Components and features include:
 - 1) 105 – 130 VAC, 1-Phase, 60 Hz
 - 2) Input: 0.5 A
 - 3) Output: SPST- Normally open isolated contact rated at 1-hp at 115 vac
 - 4) 2 thermistors rated at 10K Ohm at 77°F.
 - 5) Differential temperature control with:
 - a) On at -4°F
 - b) Off at 1.5°F.
- d. LED status indicators
- e. Digital display of pool water temperature
- f. The product must be (or be equivalent to) Model Aqua-Solar GL-235 by Hayward, 620 Division Street, Elizabeth, NJ 07201 (www.hayward-pool.com).

D. AIR SOURCE COMMERCIAL HEAT PUMP & CHILLERS

1. Air-Source Commercial Heat Pump & Chiller must be provided for each pool per the schedule in the Drawings.
2. The Basis of Design:
 - a. Commercial pools and spas: "Great Big Bopper" (GBB) high-efficiency Air-Source Commercial Heat Pump (for heating and chilling) by AquaCal Auto-Pilot, Inc.. 2737 24th Street North, St. Petersburg, FL 33713; +1.727.823.5642; WWW.AQUACAL.COM
3. Refer to model numbers indicated on the Drawings and Equipment Schedules.
4. Use a vapor compression cycle Air Source Heat Pump to extract free heat from one place (the air or pool heat source) and deliver it to another (the pool or air).
5. Performance: The heater(s) must be rated, as shown in the Drawings. Supply the following minimum equipment components & items with each heater:
6. Features:
 - a. Titanium Heat Exchanger
 - b. ICEBREAKER Modes: Heat & Cool
 - 1) Continues to heat in freezing temperatures to minimize heat loss
 - 2) Operation modes: Set to heat, cool, or auto temp
 - 3) Compressor: Maximum Efficiency Scroll-type
 - c. Corrosion Resistant Cabinet, evaporator coils, condensate drain system, and fan guards
 - d. Microprocessor Controlled with Digital Display

An accurate and easy-to-read bright blue display

 - 1) On-board self-diagnostics
 - 2) Microprocessor controlled defrost cycle

2.17 ELECTRICAL - CONTROLS, ENCLOSURES, & GROUNDING

A. GENERAL

1. Refer to the Designated Specialty Electrical Engineer's Documents for electrical components, connectors, materials, standards, additional technical specifications, executions by the Contractor. All design & equipment/materials must be coordinated with the Project Electrical Engineer as well.
2. Refer to the Complete Build requirements below for all electrical components, connectors, controls, electrical interlock on all chemical operations to de-activate when filter pumping is off, control panels, enclosures, rigid & flexible conduits, conductors, GFCI's, grounding, bonding, and earthing.
3. Electrical equipment and installations, including the grounding of the metal material, meet or exceed the National Electrical Code (NEC) and conform to the National Fire Protection Association (NFPA) 70.
 - a. Provide enclosures to include a conductive back panel for component mounting and heat dissipation
4. All Electrical enclosures provided must include adequate protection against dust and water:
 - a. If located indoors within a conditioned space (not subject to rain, sleet, snow, a corrosive atmosphere, or falling / splashing water droplets), the enclosure must be IP-54 or better [or NEMA equal].
 - b. If located outdoors or in an unconditioned space, the enclosure must be IP-55 or better [or NEMA equal].
5. All electrical enclosures exposed to corrosive / corrosion-causing fumes, or unconditioned air within 1 mile of a saltwater body of water, must be made of stainless steel, plastic, or fiberglass.
6. Electrical components must be UL Listed or ETL Listed, by an equivalent certifying agency, and NEC compliant.
7. Maintain a minimum, unobstructed clearance of 48 in [1.22 m] in front of panel boards, motor starters, VFD's, LED power supplies, lighting control panels, transformers, control panels, lighting panels, and MCC's.
8. The cabling, conductors, and wiring located in under-deck, underground, underwater conduits, & underwater junction boxes must comply with wet-rated requirements of NEC Article 300.50 (Underground & Underwater Installations) and NEC 310.10 (Wet Locations).
 - a. Note: Under-Deck cabling, conductors, conduits, & wiring must be manufacturer-rated for Underground, Underwater, and Wet locations
9. If equipment componentry is installed with noncompliant metallic parts, the item must be considered defective. It must be replaced with specified components and hardware at no additional costs for the Owner.

B. COMPLETE BUILD SCENARIO

1. Refer to the Designated Specialty Electrical Engineer's Documents or those of the Project Electrical Engineer
2. Electrical power systems
 - a. Such power systems must include but not be limited to:

- 1) Panels, circuit breakers, VFD's, magnetic motor starters, relays, overload heaters, related transformers, service disconnects, safety cut-off switches, and all deck receptacles are protected GFCI's, bonding, earthing, grounding, underwater-rated cabling, rigid & flexible conduits, and other similar systems.
3. Electrical control panel systems
 - a. Such control systems must include but not be limited to:
 - 1) Controls system, HMI, control wiring circuitry, connectors, relays, timing switches and sequencers, underwater/dry/exposed LED lights, lighting control panel system (for LED operation, LED color changing, operator LED color choices, and custom LED color selections), power supplies, related transformers, service disconnects, safety cut-off switches, auto-fill, wind sensor systems, deck receptacles, bonding, earthing, grounding, underwater-rated cabling, rigid & flexible conduits, and other similar systems to incorporate the:
 - a) Providing the control panel system(s) and the lighting control panel system(s) is a Contractor's responsibility.
 - b) Providing specialized lighting control panels for automated LED lighting, LED color selections, & nozzles systems must be in precise compliance with the logic and protocols of the manufacturer/distributor of the automated LED lighting, nozzle, auto-fill, & wind sensor controls, programming, and sequencing.
 - c) Providing specialized submersible pump circuitry, VFD's, and Industrial Ground Fault Circuit Interrupters.
 - d) Although the Drawings may graphically indicate a single control panel system, the lighting control panel manufacturer and fabricator must determine the final quantity of enclosures required to accommodate all the controls, whether for lighting or other needs. The individual control panels must comprise and equal the control panel system or systems described in the Drawings and Contractor's responsibility.
 - 2) Providing the Incorporation of filter & feature pump(s) electrical controls, chemical-system interlocks, and safety systems on UV sterilizers, chemical addition systems, gauge, and metering systems, and heaters.
 - a) The chemical addition & UV sub-systems must not be operable unless the filter system runs and delivers filtered water to the pool or water feature. This is referred to as an electrical interlock and is mandatory.
 - b) Provide a basin low-water level shutdown interlock to shut down and deactivate the pumping systems in an emergency low water condition.
 - c) Interlock the operations of all pumping systems to the operation of the filtration pump(s)
 - 3) Such electrical interlocks, GFCI's, and similar safety systems may be required by NEC, local building codes, governmental regulations, and these Contract Documents (Drawings & Technical Specifications).
4. Control Panel System (CPS) Performance Requirements
 - a. General:

- 1) The CPS must include all functions necessary to control the filtration equipment, feature systems associated with the project's aquatic features, and circuits with GFCI for compliance with the NEC.
 - 2) The CPS must be housed in stainless steel NEMA 4X enclosures and adhere to the UL508A and NEC Article 680 standards.
 - a) Exception: As indicated otherwise within this section.
 - 3) The CPS must be provided in a panel(s) configuration that must allow for its installation in the location, as identified in the design documentation.
 - 4) The panel(s) plan and elevation views layout (with dimensioned sizing) to be provided for review and approval.
 - 5) The interface must include a user-friendly industrial rated color touch screen (HMI) controlled via PLC.
 - 6) The CPS must include a 24-hour programmable time clock for days/hours operation with independent timeframe functionality for filtration and feature systems to allow variable operating hours.
 - 7) The CPS must include monitoring of all sensor devices.
 - 8) Alarms and overall systems status must be displayed, acknowledged, and influenced via this control system.
 - 9) The hardware selection and its layout must facilitate ease of maintenance and be user-friendly.
 - 10) The CPS must include remote access capabilities through the internet/web interface.
 - 11) The CPS must have the master power disconnect to deactivate all supply voltage into the panel for safety troubleshooting.
 - 12) The CPS must include an AC-DC Power Supply for the components that require that type of Voltage.
 - 13) All fittings and adapters connected to the CPS must be Liquid-Tight.
 - 14) All conductor/wiring splice connectors must be of the Lever-Actuated, Cage-Clamp with side-entry
 - 15) All wiring within the CPS must be performed, grounded/bonded per NEC compliance, and manufacturer's instruction manuals.
- b. Typical Pump Systems
- 1) The CPS must include monitoring and controlling the pump(s) on/off/fault function.
 - 2) The flow switch(s) must include proof of flow to the CPS, which in turn must cease pump(s) function through connection to the VFD(s) if no flow is detected.
 - 3) During pump(s) startup, the CPS must provide a delay of 2 minutes for proper pump ramp-up before flow switch activation.
 - 4) The CPS must monitor the pressure sensor(s) readings upstream and downstream of each pump(s). Note: if pressure sensors are not utilized, then this requirement is deleted.
 - 5) The CPS must include monitoring flow sensor(s) readings and providing a VFD(s) signal to calibrate desired flow rates.
- c. Typical Filtration Systems

- 1) For automated-backwash or bump-style filters, the CPS must monitor the pressure sensor(s) readings upstream and downstream of the filter(s).
- 2) For automated-backwash or bump-style filters, the CPS must include monitoring filter(s) on/off/fault function.
- 3) The CPS must include control & monitoring of the filter control panel(s) to ascertain pre-coat & backwash cycles and maintain proper flow rates during non-filtration cycles (if required).

d. Typical Heater Systems

- 1) For heaters greater than 500 kBtu/hour, the CPS must include control & monitoring of on/off function.
- 2) For heaters that are 500 kBtu/hour or higher, the CPS must include the ability to set a goal temperature and monitor the pool temperature, using either Modbus or 0-10V analog input and output signals.
- 3) The CPS must include an electrical interlock between the pump(s) and heater(s) to safeguard all heater operations cease when the pump is not functioning (if the heater controller does not have built-in protection to stop operation when no water flow or a high temperature reading in the system).

e. Typical Chemical Control Systems

- 1) The CPS must include control & monitoring of the chemical controller on/off function. The chemical controller includes a separate monitoring system where the owner must monitor operation and chemical data.
- 2) The CPS must include an electrical interlock between the filter/feature pump(s) and chemical feed system(s) to prevent chemicals from being injected into a pipe with no flow.

f. Typical Potable Water Fill Systems

- 1) The CPS must include control & monitoring on/off function.
- 2) The CPS must include monitoring and controlling associated level sensor(s) & control valve(s).

g. Typical Underwater Lighting Systems

- 1) The CPS must include control & monitoring on/off function.
- 2) The CPS must include days/hours of operation control/photocell or both on underwater lighting circuits.
- 3) The CPS must include complete controls for LED on/off/auto operation, color-changing, operator color choices, and pre-selection of colors or custom color selections.

5. Bonding, Earthing, & Bonding of components are inclusive and must be provided within the Complete Build Scenario.

C. BONDING, EARTHING, & GROUNDING

1. Refer to the Designated Specialty Electrical Engineer's Documents.

2. Each nozzle, LED light, and specialty metallic component must be equipped with bonding/grounding UL-Listed lugs and capable of being bonded/grounded (fabricated from the same material as the body to which it is attached), bonded, earthed, & grounded per these Specifications, the Drawings, the requirements of NEC, and the requirements of the manufacturer. An UL / ETL Listing / NEC (or an equivalency) certification is required.
3. If the bonding/earthing/grounding lugs are not provided by the manufacturer, the Contractor must provide the necessary bonding/grounding UL-Listed lugs.
 - a. The bonding/grounding UL-Listed lugs must accommodate a #8 solid, copper conductor (bare if buried in the earth or waterproof insulated if within the basin) per the requirements of NEC 250.8

D. CIRCUIT BREAKER PANELBOARDS

1. Refer to the Designated Specialty Electrical Engineer's Documents for all circuit breaker panelboards & enclosures.
2. Provide bottom feed feature unless otherwise noted in the Drawings.
3. The recommended Basis of Design:
 - a. Crouse-Hinds model # XLPD
 - b. Square-D (as equivalent to the above)
 - c. Westinghouse (as equivalent to the above)
4. One Master Circuit Breaker is required for each panel

E. BRANCH CIRCUIT BREAKERS

1. Refer to the Designated Specialty Electrical Engineer's Documents for all circuit breakers.
2. Circuit Breakers must be by the same manufacturer as the Panelboard.

F. CONDUIT

1. Refer to the Designated Specialty Electrical Engineer's Documents.
2. Provide non-metallic, rigid, or approved flexible, Type 1 for the interior, exterior, under-deck, underground, and underwater locations.
 - a. Wiring inside the pool equipment area, mechanical space, or enclosure must be encased in rigid Type 1 conduits.
 - b. Underwater light conduits must be 1-inch [25 mm] diameter rigid Type 1 from the low-voltage power supplies/transformer to each light niche and waterproof/waterproof without exception.
3. Conduit sizes must adhere and follow the NEC, Chapter 9, Table #B for concentric stranded "THWN" copper conductors in schedule 40 PVC (rigid or approved flexible nonmetallic conduits), minimum allowable sizes for either:
 - a. 4-wire, 3-phase bundle, or
 - b. 2-wire + ground, 1-phase bundle

G. CONTROL RELAYS

1. Refer to the Designated Specialty Electrical Engineer's Documents.

2. Control relays must be "industrial duty" and rated for continuous operation. Each unit must be 2-pole and equipped with both normally closed and normally open contacts for each pole.
3. Control Relay: 120 VAC, DPST
 - a. 120vac coil, 60 Hz, DPDT
 - b. 8-pin Octal Base
 - c. Socket # 5B586 (socket code A)
 - d. 12A contact rating (resistive)
 - e. 13.2A contact rating (inductive)
 - f. Coil VA rating at 3.5
 - g. DIN rail/screw mount
 - h. 2.4" L x 1.6" W x 0.83" H
4. The Basis of Design: Model #2DT07 with Socket #5B586 (or as noted in the Drawings), by Square-D or an approved equal

H. ELECTRICAL ENCLOSURES

1. Refer to the Designated Specialty Electrical Engineer's Documents.
2. Include the following: Seamless foam-in-place gasket.
3. Internal 3-point latch
4. Powerglide handle.
5. The door must be capable of being removed by pulling a continuous hinge pin.
6. Collar studs for mounting back panel
7. Bonding provision on the door with a UL-Listed grounding lug on the body.
8. Provide window kits for panel enclosures housing meters and chemical controllers.
9. Hardware:
 - a. Material: stainless steel (nuts, bolts, washers).
 - b. Verify metallic components exposed to or submerged in chlorinated water must use only stainless-steel Grade 316 hardware (nuts, bolts, washers, and misc. items).
 - c. Cast-Iron castings or steel components exposed to or submerged in chlorinated water or coastal salt-laden air must be epoxy-fused.
10. Unistrut must be provided if required for mounting. All Unistrut must be stainless steel with stainless fasteners.

I. ELECTRICAL RECEPTACLES

1. General:
 - a. Refer to the Designated Specialty Electrical Engineer's Documents.
 - 1) Incorporate bonding provisions with a UL-Listed grounding lug on the body.
 - b. Refer to the Drawings for the locations and quantities of the receptacles specified.
 - c. Each receptacle must be a Class A GFCI-protected device.
2. Pool-side:
 - a. Provide weatherproof poolside receptacles for the powering of the portable vacuum system(s) and compliance with the National Electric Code.
3. Convenience:

- a. 120VAC, 1-Phase, 60 Hz
 - b. 20-amp rating
 - c. Mounted in a NEMA 3R enclosure unless otherwise noted in the Drawings
 - d. Suitable for equipment yard or pool deck area
4. Portable vacuum:
 - a. An outdoor receptacle for the powering of the portable, wheeled-vacuum equipment to include:
 - 1) Corrosion-resistant materials
 - 2) 54-inches [1.37 m] total length with 24-inches [0.61m] above the soils
 - 3) 250V rating
 - 4) 15-amp trip rating
 - 5) NEMA 6-15 Single; 2P, 3W, Straight-Blade configuration
 - 6) Suitable for a 1-hp, 208VAC portable vacuum pump (Plug-In); Maximum FLA = 8.3 amps
 - b. The Basis of Design: PEDOC Power Solutions, LLC; 847.815.6125;
www.pedocpower.com
- J. ENCLOSURE AND PANEL IDENTIFICATION LABELS & ID'S
 1. Refer to the Designated Specialty Electrical Engineer's Documents.
 2. Install custom engraved phenolic labels on controls and electrical panels/enclosures.
 - a. Equipment Spaces are required to use phenolic labels to comply with OSHA safety regulations, ISO guidelines.
 - b. Provide phenolic labels in locations where a durable label is a necessity and in the following typical locations: Cutout switch labels, electrical panels, identification panels, service disconnects, name-plates, and door-plates
 3. Unless specified otherwise by codes, utilize the colors noted herein.
 4. Approved Label / Tag Manufacturer: Carolina Design Company, PO Box 812, Clover, SC 29710 tammie@phenoliclabels.com
 - a. Alternate manufacturers may be considered; however, their quality must comply with those from Carolina Design Company (above).
- K. MAGNETIC MOTOR STARTERS
 1. Refer to the Designated Specialty Electrical Engineer's Documents.
 2. Provide magnetic motor starters and solid-state overload relays for each 3-phase pump motor in the various mechanical room and areas unless a VFD is specified for that motor
 3. Coil voltage: 120VAC, 60 hertz unless otherwise noted on the Drawings.
 4. The coil must electrically interconnect 120 VAC type components that must operate only when the starter is energized.
 5. Include 1 N.O. auxiliary contact set.
 6. The Basis of Design: Square-D "Class 8536" Series as supplied by Square-D.
- L. MOTOR DISCONNECT SWITCH
 1. Refer to the Designated Specialty Electrical Engineer's Documents.
 2. Verify and confirm the power rating for each disconnect switch.

3. Early-break auxiliary contacts (1 N.O. and 1 N.C.)
4. Bonding/grounding provision with a UL-Listed bonding/grounding lug on the metallic-body.
5. The Basis of Design: Nonmetallic HDI Series or an approved equivalent by Mennekes Electronics, www.mennekes.com.

M. PHOTO-CELL SWITCH

1. Refer to the Designated Specialty Electrical Engineer's Documents.
2. Provide a photocell switch with the following features:
 - a. 120 VAC, Normally-Open (N.O.) contacts
 - b. Closed at 1 – 5-foot candles
 - c. Opens at 3 – 15-foot candles
 - d. 15A rating (tungsten)
 - e. 1800-watt rating (tungsten)
 - f. 1-Watt power consumption
 - g. Cadmium sulfide photocell with sealed polycarbonate housing and lens
 - h. 9-inches leads
 - i. Bonding/grounding provision with a UL-Listed grounding lug on the metallic-body.
 - j. Fits within a standard exterior outlet box rated at NEMA 3R
3. Provide Model #K4321C by Intermatic; www.intermatic.com or approved equal.
4. A UL / ETL Listing / NEC (or an equivalency) certification is required.

N. THERMOELECTRIC AIR CONDITIONERS FOR NEMA 4X ENCLOSURES

1. Refer to the Designated Specialty Electrical Engineer's Documents.
2. Unless expressly noted herein, each NEMA enclosure installed in a non-ventilated space or outdoors in direct sunlight must include two (2) cooling units.
3. Cooling unit:
 - a. Thermoelectric air conditioners rated at a minimum of 400 BTU/hour each
 - b. Rated for NEMA 4X enclosures; the unit is grade 316L stainless steel
 - c. Vertically-mount in a sidewall enclosure; the unit is 12-inches x 6 inches [305 mm x 150 mm] with a mounting bracket
 - d. Solid-state components 120-Vac 50/60 Hz, 2 amps
 - e. Bonding/grounding provision with a UL-Listed bonding/grounding lug on the metallic-body.
4. Manufacturer: EIC Solutions, Inc., 700 Veterans Way, Suite 200, Warminster, PA 18974, USA

O. TIME DELAY RELAY

1. Up to 5-Minute: 120 VAC Coil, DPDT
2. Contact rated to 5 amps (resistive)
3. Adjustable energize delay to 10-minutes maximum
4. 8-Pin (socket code K)
5. Order with 8-Pin socket Omron
6. Model # H3YN-2 AC100-120 or pre-approved equivalent by Omron Corp.;
www.omron.com

P. TIMECLOCKS & TIME SWITCHES

1. Refer to the Designated Specialty Electrical Engineer's Documents.
2. Electromechanical time clock(s) must be provided with the following features:
 - a. 120VAC, DPDT – Normally Open (N.O.) contacts with 40A rating
 - b. 7-day timer with a 15-minute timing interval
 - c. Auto-voltage select (120VAC to 277VAC)
 - d. Real-time clock face
 - e. On-Off-Auto Override switch
 - f. Amber and Green LED power and status lights
 - g. 24-hour battery backup in the event of a power loss
3. The Basis of Design:
 - a. Provide model # GM40AV-QW by Intermatic, Inc.; www.intermatic.com or an approved equal.
 - 1) Incorporate a bonding provision with a UL-Listed grounding lug on the body.
4. Timeclock appropriate functions
 - a. The following features must be controlled via the time clocks:
 - 1) Each Pool's underwater lights (mount timer in the Equipment Room)
 - 2) Each Pool's feature pumps (mount timer in the Equipment Room)
5. 15-minute mechanical timer switch with the following functions:
 - a. Without hold over-ride
 - b. SPST Auto-Off Timer
 - c. 20A pole rating (resistive)
 - d. 125VAC, 5060 Hz
6. The Basis of Design: Model # FF15MC by Intermatic, Inc.; www.intermatic.com.

Q. UNDERGROUND / UNDERWATER ELECTRICAL CABLES, CONNECTORS, & CONDUCTORS

1. Refer to the Designated Specialty Electrical Engineer's Documents.
2. Conductors must be copper with insulation suitable for the location.
3. Wires/conductors for grounding, earthing, and bonding must be:
 - a. #8 AWG bare, solid copper cable (if encased in concrete). Otherwise,
 - b. #8 AWG insulated solid copper cable.
 - c. Conduit encasement for bonding, earthing, or ground wires are prohibited.
4. Rated under-deck, underwater, and underground electrical cable and conductors must be encased in waterproof, sealed PVC conduits rated for continuous operation in marine, underwater, and underground wet environments.
5. Under-deck, underwater, and underground cables, conductors, cords must be rated for wet conditions and locations and be supplied, encased in a waterproof conduit, with the appropriate cord length intact with the following:
 - a. Moisture-impervious metal-sheathed
 - b. Allowable conductor types THWN
 - 1) Alternate wiring types (only with specific approval from This Engineer) may be MTW, RHW, RHW-2, TW, THW, THW-2, THHW, THWN-2, XHHW, XHHW-2, or ZW

- a) Exception: concrete-encapsulated bonding, earthing, or grounding wires.
- c. Size per NEC Table 310-16, rated at 75 Deg C., operating at a maximum ambient temperature of 122 Degree F. [50 Degree C.]
- d. Be a type listed for use in wet locations
 - 1) CAT 5E wet-rated cables must be Mohawk, "VersaLAN CMR/CMX" - or equal
 - 2) Encase all insulated conductors in a waterproof conduit.
- e. DMX cable must be TMB ProAqua cable model PCAQ224UL**
 - 1) Basis of Design: TMB ProAqua Submersible Cables; 527 Park Avenue San Fernando, CA 91340, USA; +1.818.899.8818; WWW.TMB.COM
- 6. The interior of conduits, enclosures, or raceways installed under-deck, underwater, and underground must be considered a wet location.
 - a. Insulated conductors and cables installed in these conduits, enclosures, or raceways in under-deck, underwater, and underground installations must be listed to allow in wet locations and comply with NEC 310.10.
 - b. Connections or splices in an under-deck, underwater, and underground installation must be approved for wet locations.
 - c. Cables & conductors located underground must be wet/submersible rated and capable of water chemistry containing mild chlorine (up to 5 ppm) and pH range: 6 to 9.
- 7. Splicing Connectors:
 - a. Splicing connectors in junction boxes and control panels must utilize Cage-Clamp with spring pressure connection technology via lever actuators.
 - 1) Critical: Wire-Nut connector-types are disallowed and not permissible on this project.
 - b. Each device must be capable of accommodating solid conductors, stranded conductors, and fine-stranded conductors.
 - c. Provide manufacturer-approved mounting adapters as needed for conductor management.
 - d. Basis of Design:
 - 1) Series 222-xxx for splicing connectors
 - 2) Series 773-xxx Push-Fit for grounding and bonding connectors
 - 3) WAGO Corporation; N120w19129 Freistadt Rd, Germantown, WI 53022, Phone: +1.888.828.4592; Email: info.us@wago.com | Web: www.wago.com

R. VARIABLE FREQUENCY DRIVES

- 1. Refer to the Designated Specialty Electrical Engineer's Documents.
- 2. Variable Frequency Drive (VFD) inverter units must be provided for each 3-phase pump motor, as listed on the Drawings.
- 3. VFDs intended for the Defender Filter must be capable of interfacing with the Defender RMF controller
- 4. VFD must be a six-pulse input design.

5. VFDs must be solid-state, with a Pulse Width Modulated (PWM) output utilizing current IGBT inverter technology and voltage-vector-control of the output PWM waveform. This waveform closely approximates a sine wave.
 - a. Option for Single Phase Input: The VFD must convert incoming fixed frequency single-phase AC power into a variable-frequency and voltages for controlling the speed of three-phase AC induction motors. The VFD must be UL-listed for a Single-Phase operation. De-rating the VFD for operation on other than UL-labeled voltages must not be acceptable.
6. VFD must utilize VVCPLUS, an output voltage vector switching algorithm, or equivalent, in both variable and constant torque modes.
 - a. VVCPLUS provides rated RMS primary voltage from the VFD.
 - 1) VFD's that cannot produce rated RMS fundamental output voltage or require the input voltage to be increased above motor-nameplate value to achieve rated RMS primary output voltage is not acceptable.
 - 2) VFD's that utilize Sine-Coded PWM or Look-up tables must not be acceptable.
7. Provide an Automatic Energy Optimization (AEO) selection feature that must be provided in the VFD.
 - a. This feature must enhance motor magnetization voltage and dynamically adjust output voltage in response to load, independent of speed.
 - b. Output voltage adjustment based on frequency alone is not acceptable for single motor VT configurations.
8. Provide an Automatic Motor Adaptation (AMA) function to measure motor stator resistance and reactance.
 - a. It must not be necessary to spin the motor shaft or decouple the motor from the load to accomplish this optimization.
 - b. Parameters for motor resistance and motor reactance must be user-programmable.
9. Provide a Run Permissive Circuit to accept a "system ready" signal ensuring the VFD does not start until isolation valves, seal water pumps, and other types of auxiliary equipment are in the proper state for VFD operation.
 - a. The Run Permissive Circuit can send an output signal as a start command to actuate external equipment before allowing the VFD to start.
10. Provide an ability to detect or infer a no-flow condition (high rpm but low power consumption) and then disconnect the motor when detected.
 - a. In the manual for the Danfoss VLT Aqua, this functionality is available in the factory programming. It is called the "No Flow Function." Other VFDs may have similar functionality. The Contractor must ensure the functionality is programmed before the VFD is shipped to the job site.
11. Green Drive VFDs must be factory programmed to filter pump, remote start/stop requirements, confirm requirements, and PID loop requirements.
12. VFDs and options must be UL, CUL, and CE-labeled as a component.
13. Harmonic Distortion Control:

- a. The VFD must provide internal DC link reactors to minimize power line harmonics and provide a near unity power factor.
 - b. DC Link reactors must be installed so that power fluctuations to the DC Capacitors are reduced to increase Capacitor's life.
 - c. VFDs without a DC link reactor must provide a 05% impedance line side reactor and spare capacitors.
14. Performance Requirements:
- a. Voltage tolerance + 10% or – 15% of specified line voltage.
 - b. Output Frequency 30 to 90 Hz.
 - c. Environmental operating conditions:
 - d. 14-deg F. to 122-deg F. [-10-deg C. to 50-deg C]
 - e. 0 to 3,280.8-feet [0 to 1000 m] above sea level
15. VFD must be wired into the Defender RMF controller, if present, for on/off and confirm functions.
16. Provide VFD's with the following specified properties:
- a. A Shorting Contactor, Isolation Contactor, and Inverter Contactor
 - b. Overload Relay
 - c. Thermal overload protection
 - d. Voltage and current surge limitation via circuit breakers and fuses
 - e. Integrated hand/off/auto control via the Digital Keypad
 - f. Manual bypass for relaxed, non-automated, Programmable Soft-Start operation and Ramp-Up periods
 - g. Load Inductors and Interfacing Controls consisting of Digital Keypad mounted on the front of the specified NEMA Enclosure or as indicated on the Drawings.
 - h. Pilot Lights (by-pass-on, power-on, and drive-on)
 - i. Control wiring interconnectivity between the VFD and RMF to verify proper communications with automatic devices (filtration controls, chemical controller, chemical controls, pumping controls, UV sanitizers, and similar equipment. Include hard contact terminals (to distribute 120V Control Power)
 - j. Pre-installed provisions for a bolt-on direct connect cooling unit in the enclosure
 - k. Continuous display of operating parameters of the motor (Hz, volts, amps)
 - l. Programmable soft start for reduction of power company demand charges and reduced water hammer potential
 - m. Must be interfaced with the RMF controller, if present, and flow sensors to provide direct command of circulation system flow rate for maximum energy savings
 - n. Interfaces with energy management system via Modbus RTU if present
 - o. The various VFDs' control operations must activate or de-activate related chemical feeder's systems through a 120-vac coil, VFD control, VFD via RMF hard contacts, or relays.
 - p. Each new drive must be fed from a breaker located in either an MCC or Power Distribution panel.
17. The Basis of Design:
- a. Neptune Benson Green Drive – Required for Defender Systems.

- b. Danfoss VLT Aqua – Allowed for Filter Pumps other than Defender, and Feature Pumps
- c. Armstrong Pumps – Motor-mounted VFD Allowed if Armstrong Pumps are specified
- d. Current Systems Inc. – Allowed for the River Flow Thrusters systems

S. INDUSTRIAL GROUND FAULT CIRCUIT INTERRUPTERS

1. General:

- a. The Industrial ground fault circuit interrupter(s) must be provided for each submersible (basin-located) pump assembly.

2. Basic Features

- a. The Industrial Ground Fault Circuit Interrupters (GFCIs) are solid-state relays that extend the capabilities of standard GFCIs to the detection of ground leakage currents in all stages of power conversion equipment, from simple rectifiers to sophisticated variable frequency drives.
- b. Industrial GFCIs must detect both AC and DC ground leakage current. The device must be available in a range of voltages, load amperages, and options.
- c. Industrial GFCI's must be simple to install and require a minimal amount of connections.
 - 1) Provide for internal mounting within the Control Panel
- d. For grounded and high-resistance grounded systems
- e. Voltage options up to 250 VAC
- f. Single-phase or three-phase AC systems
- g. Works on systems with DC components and systems with variable frequency drives (VFDs)
- h. Included options for adjustable trip level
- i. Built-in ON and Alarm indications
- j. Test and Rest pushbuttons
- k. Digital display showing ground-fault current in real-time
- l. Must support the manufacturer's remote communication system
- m. Open type (no enclosure) models are recognized components
- n. Closed type (in enclosure) models with applicable voltages up to 100 A listed as Class A devices

3. Manufacturer Certified Applications

- a. Industrial ground fault interruption in single- or three-phase AC systems up to 250 VAC
- b. Systems with DC components
- c. Systems with variable frequency drives (VFDs)

4. 6-mA Trip Level with Inverse Time Curve Required

- a. The Industrial GFCI must feature a 6-mA trip level.
 - 1) The unit's trip operation must comply with UL943, the standard for personal protection.
 - 2) The minimum response time is 25-ms at leakage currents of 250-mA and above.
 - 3) No degradation in performance after 1 million cycles

- 4) Models up to 100 A using system voltages 240 V line-to-line and below are Class A ground fault circuit interrupters.
5. The Basis of Design: BENDER LifeGuard Series GFCI (Industrial); Bender Inc.
420 Eagleview Blvd. Exton, PA; 800-356-4266 or 610-383-9200; info@bender.org
www.bender.org

2.18 NOT USED

2.19 NOT USED

2.20 VALVES, CHECK VALVES, & OPERATORS

A. GENERAL REQUIREMENTS

1. Valves must be compatible and suitable with mildly chlorinated water typical for pools, water features, and saline type water (less than 7,000 ppm).
 - a. Internal parts must be removable for inspection and complete replacement without applying heat or breaking pipe connections.
 - b. Valve shafts must be Grade 316L stainless steel unless otherwise noted.
 - c. Valve hardware (bolts, nuts, washers, and misc. metallic components) must be stainless steel, Grade 316L.
 - d. The valve must have a round disc design for increased CV, high cycle life, and final sealing.
 - e. The valve body must have integrally molded body stops and seat relief areas to prevent the mating flanges' over-tightening. Valves must accept flat-faced flanges per ANSI B16.5 bolt pattern for 150 lb. Flanges. Exception: Plastic valves: manufacturers recommended tightening procedure must be followed to prevent over-tightening.
 - 1) Exception:
 - a) If a liner is utilized, the liner must be 100% seat design fully molded around the body, whereas only the Disc and Seat are wetted parts and feature raised convex rings on the face and be utilized as the mating flange gaskets.
 - f. Valve joints must be prepared using flanged connections to accept either wafer style or lugged butterfly valves.
 - g. Valves placed in "difficult-to-reach" locations or more than 7-feet [2.13 m] above the floor elevation must have chain operators or extended valve operators as pre-approved by This Engineer.
2. Pressure and Temperature Minimum Ratings:
 - a. Valves must be rated for 150 psig [1135 kPa] pressure ratings and at least a maximum temperature of 120° F [48° C]
 - b. 1/2 inch [12 mm] through 24-inches [600 mm] flanged valves must be pressure rated to 150 psig [1135 kPa].
3. Valves must be open when turned counter-clockwise.
4. Proportional-flow valves: All recirculation pipes to and from the pool must be individually valved with proportional flow-type valves to control the recirculation flow.

5. NSF International must certify valves for use in potable water service and those specified in This Section.
 - a. Valves must be rated as complying with NSF-50 or NSF-61 (drinking water) standards.
 - b. Metallic valves (and their handles or operators) must be stainless steel or epoxy-fused coated (NSF-61 compliant).
6. The maximum water velocity allowed through thermoplastic-type valves must be 5.0 fps [1.524 mps]. Valves located in positions with water velocities that exceed 5.0 fps [1.524 mps] must be metallic and manufacturer rated for those flow velocities.
 - a. Exception: This Engineer may consider higher water velocities if those higher water velocities are certified in writing explicitly as permissible by the valve manufacturer.
7. True-Union connections are mandatory on all butterfly, gate, and globe valves mounted in self-contained Fiberglass Pre-Assembled filtration, chemical, and pumping pak-type systems.
8. Valves (and check valves) placed into compressed air systems must individually be rated for use with the manufacturer's compressed air.
9. Cast Iron valves 3-inches and larger must have an epoxy coated body on the interior and exterior surfaces, ductile iron-nylon II coated disc, one-piece 416 stainless steel shaft with Buna-N, EPDM, or VITON seat minimum, 150 PSI rating Internal components include EPDM resilient lining, Rilsan coated ductile iron disc and T304 (or better) L stainless steel shaft
10. Cast Aluminum valves sized at 2-inches and larger must have an ASTM S12A body, coated with Rilsan on the interior and exterior surfaces, or an ASTM B26 Class B body without coating if the valve body is not wetted. Internal components include Buna-N or EPDM resilient lining and seat. Internal components include EPDM or BUNA-N resilient lining, a disc made of Rilsan coated ductile iron or uncoated stainless steel, and T304L stainless steel shaft.
11. Thermoplastic Valves 3 inches and larger must be constructed from PVC Type 1 Cell Classification 12454 or CPVC type 4 cell classification 23447. Thermoplastic valves must include PVC disc with solid type 316L stainless steel shaft with Buna-N, EPDM, or VITON seat pressure rated to 150 psi @ 73 degrees Fahrenheit.

B. APPROVED MATERIALS

1. PVC – Conforming to ASTM D1784 Cell Classification 12454
2. CPVC – Conforming to ASTM D1784 Cell Classification 23447
3. Polypropylene – Conforming to ASTM D4101 Cell Classification PP0210B67272
4. PVDF – Conforming to ASTM D3222-91A Cell Classification Type II
5. UV Inhibitors: Mandatory for plastic valves and components if located exposed to sunlight
6. FKM – VITON® Fluorocarbon Rubber (also referred to as VITON)
7. EPDM – Ethylene Propylene Diene Terpolymer Rubber
8. Nitrile – Nitrile Butadiene Rubber
9. Ball valve O-rings must be EPDM or VITON®.
10. Lugs, Operating Nuts, Stem Extensions, Shafts, and Valve Hardware:
 - a. Stainless steel, per ASTM-A276, in Grade 316L.

- b. Butterfly Valve Disc Assembly: Offset design with entirely isolated Type 316L stainless steel stem and Type 316L stainless steel hardware.
 - 11. Cast Aluminum housing with Rilsan (nylon) coating
 - 12. Stainless Steel, grade 316L or better (unless otherwise noted in the Drawings)
 - 13. Operator component requirements:
 - a. Unless noted otherwise, actual lever handles, gear handles, chain components (wheel, chain, and similar equipment) must be one of the following:
 - 1) Epoxy fused coated
 - 2) Stainless steel, Type 316L or better
 - 3) High impact polypropylene handle/handwheel
- C. PRE-APPROVED VALVE AND MANUFACTURERS
- 1. The Basis of Design for Plastic-type valves (for less than 5 FPS [1.524 MPS] water velocity applications):
 - a. ASAHI America
 - 1) Type-57 Butterfly valves must be PVC, PP, or PVDF bodies with either PP, PVC, PVDF disc and EPDM, Nitrile, or FKM seat & seals.
 - 2) Classifications approved:
 - a) Ball Valves: up to 3-inches [80 mm]
 - b) Butterfly Valves: 1.5-inches [40 mm] and larger
 - b. Spears
 - 1) PVC & CPVC 2000 Industrial True Union Ball Valve
 - a) Ball check valves must be CPVC (ADE Type 3)
 - 2) Classifications approved:
 - a) Ball Valves: up to 3-inches [80 mm]
 - b) Butterfly Valves: 1.5-inches [40 mm] and larger
 - c) Globe Valves: up to 6-inches [150 mm]
 - 2. The Basis of Design for Metallic valves:
 - a. Dominion Valves by Neptune Benson
 - 1) Valves 3-inches to 12-inches [75 - 305 mm] must be constructed with cast aluminum ASTM S12A housing and entirely coated with Rilsan on the interior and exterior surfaces. Internal components include EPDM resilient-lining, Rilsan-coated ductile iron disc, and T316 stainless steel shaft
 - 2) Valves 14-inches [355 mm] and larger must be constructed with cast iron housing epoxy coated, and Rilsan coated ductile iron disc.
 - 3) Valves must be Dominion butterfly valves and must be provided for strainer isolation, filter bypass, backwash throttling, filtered water return, and balance tank connections.
 - 4) Classifications approved:
 - a) Butterfly Valves: 2-inches [50 mm] and larger
 - b. Val-Matic Series 2000 valves

- 1) Provide valves manufactured and tested per American Water Works Association Standard ANSI/AWWA C504 and certified to ANSI/NSF 61 Drinking Water System Components-Health Effects.
- 2) Provide valve body metallic parts with factory-primed and epoxy-fused coated resistant to chlorine and mild saline water (7,000 ppm) associated with saline-based chlorine generators.
- 3) The manufacturer must demonstrate a quality management system certified to ISO 9001:2000 by an accredited, certifying body.
- 4) Classifications approved:
 - a) Butterfly: 2-inches [50 mm] and larger
- c. Bray Series 20 and 21 valves
 - 1) Aluminum body
 - 2) Uncoated Stainless-Steel disc
 - 3) EPDM or BUNA-N seat material
3. Flanges and Hardware:
 - a. Plastic piping must have plastic flanges (with equivalent pressure ratings);
 - b. Stainless steel piping must be equipped with stainless steel flanges.

D. OPERATORS

1. General requirements:
 - a. Metallic components for operators must be stainless steel unless approved by This Engineer.
 - b. Valve hardware (nuts, bolts, washers, and similar equipment) must be 316L stainless steel.
2. Lever Type Operator:
 - a. Only for standard sizes 1.5 – 6-inches [40 – 150 mm]. Lever operators may not be used in sizes larger than 6-inches [150 mm].
 - b. Must have built-in lockout capability.
3. Gear Type Operator:
 - a. Mandatory for standard sizes 8-inches [200 mm] and larger
 - b. Gear operators are acceptable for sizes smaller than 8-inches [200 mm] as well
 - c. Must be equipped with a position indicator.
4. Chain Type Operator:
 - a. Mandatory for valves located 7-feet [2.13 m] or higher above the floor elevation.
 - b. Chain operators may be installed on Gear-operated butterfly valves. The chain must be a weldless loop style chain.

E. DISCRETE AUTOMATED ACTUATORS

1. Pneumatic
2. Electric
3. Actuation accessories to be provided and installed per manufacturer's requirements.
4. Minimum features must include:
 - a. An actuator at 120 VAC, 60-Hz

- b. Two adjustable limit switches for cycle adjustment
- c. Visual position indicator
- d. Maximum 33-second travel time
- e. 0.7-amp FLA
- f. Mounted in a NEMA 3R enclosure under otherwise noted in the Drawings

F. PROPORTIONAL AUTOMATED ACTUATORS

- 1. When specified in the Drawings, a proportionally controlled electric actuator must be supplied by the same manufacturer supplying the valve body and stem to safeguard compatibility
- 2. Pneumatic powered
- 3. Must include a positioning board which accepts a 4-20mA signal
- 4. Minimum travel: 355 degrees of rotation
- 5. Maximum cycle time with 90 psi: 1 second
- 6. Minimum duty cycle: 35%
- 7. The Basis of Design: Bray 6A

G. ISOLATION AND THROTTLING VALVES (2-INCHES AND LESS)

- 1. Isolation and throttling valves of 2-inches [50 mm] and less in size must be true-union ball valves.
 - a. Refer to the Drawings for specific types specified.
- 2. Materials of construction must be Type 2. The "true-union" design must allow valve removal and replacement without spreading the pipelines adjacent to the valves.
- 3. Valves must be full port and have replaceable Teflon seats. Valves must have a blowout-proof stem and a handle that can be easily removed.
- 4. Valves must have:
 - a. a Safe-T-Shear® stem with double O-ring stem seals.
 - b. Handles must be polypropylene with a built-in lockout mechanism,
 - c. union nuts must have Buttress threads.
- 5. Seal carriers must be Safe-T-Blocked®.

H. ISOLATION AND THROTTLING VALVES (2.5-INCHES AND GREATER)

- 1. Isolation and throttling valves of 2.5-inches [65 mm] and greater in size must be of the butterfly type.
 - a. Refer to the Drawings for specific types specified.
- 2. Materials of construction must be Type 2.
 - a. The valve body must be Type 2.
 - b. The valve disc must be Type 2.
 - c. The valve shaft must be stainless steel.
- 3. Seat materials and other elastomers must be rated for continuous chlorinated water and saline content water service and must be EPDM or better.
- 4. The valves must be rated for "bubble-tight" service unless otherwise specified. Valves between 2.5-inches [65 mm] and 6-inches [150 mm] must have lever-style operators unless indicated otherwise.

5. Valves 8-inches [200 mm] AND greater in size must have gear-type operators.
6. The valves must be wafer-style and must fit between standard ANSI flange construction.
- I. PRECISION THROTTLING GLOBE VALVES (UP TO 6-INCHES)
 1. Precision throttling valves 6-inches [150 mm] and smaller in size must be of the Globe type.
 2. All thermoplastic Globe valves must be constructed from PVC (Type 2), or CPVC (Type 2), or U-PVC – Conforming to ASTM D1784 Cell Classification 12454 A, as specified in the Drawings.
 3. Seals must be FKM – VITON® Fluorocarbon Rubber or EPDM – Ethylene Propylene Diene Terpolymer Rubber
 4. Globe valves with "floating disks" are expressly prohibited.
 5. There must be no metal to media contact. Valves must have excellent flow regulating characteristics throughout the entire lift of the disc.
 6. Valves must have a high impact polypropylene handwheel.
 7. PVC and CPVC -1/2 inch [12 mm] through 4-inches [100 mm] globe valves must be pressure rated to a minimum 80 psi [551 kPa] or higher for water at 73°F [22.8°C]. Sizes must be rated for full vacuum service 29.9 inch/Hg.
 8. The Basis of Design:
 - a. Spears Y-pattern True-Union PVC Globe Valve, www.spearsmfg.com, 800. 327.6390
- J. CHECK VALVES (1.5-INCHES AND LESS)
 1. Thermoplastic check valves 1.5-inches [37mm] and less must be True-Union 2000 Industrial Ball Check type manufactured to ASTM F-1970 and construction materials from Type 3 (CPVC Type IV), ASTM D-1784 Cell Classification 23447.
 - a. The check valve design must allow installation in either a horizontal or vertical position.
 - b. CPVC 1/2 inch through 1.5-inch ball check valves must be pressure rated to 235 psi at 73°F.
 - c. Note thermoplastic water velocity limitation as indicated above
 2. Suitable for pressure and vacuum service
 3. The valve ball must be the only moving part and must unseat to permit flow in one direction, but seal against its seat to prevent backflow. The minimum 100% shut-off pressure must not exceed 0.7 psi [4.82 kPa].
 4. The valves must have one of the following end-connections: socket-weld with true-unions on both ends
 - a. CPVC (Type 3) Flange connectors are required as the Drawings specify.
 5. Materials:
 - a. O-rings and seals must be EPDM or VITON. Seal materials and other elastomers must be rated for continuous chlorinated water and saline content water service.
 - b. Valve union nuts must have Buttress threads.
 - c. Valve seats must be a standard O-ring type.
 - d. Seal carriers must be Safe-T-Blocked®.
 - e. Valve components must be replaceable.

- f. Components must be assembled with Silicone-Free, Water Soluble Lubricants
- g. NSF must list EPDM valves® for use in potable water service.
- h. The valve body, ball, and other components must be Type 3.

6. The Basis of Design:

- a. Model True Union 2000 Industrial Ball Check Valves as manufactured by Spears Manufacturing Company, 15853 Olden St., Sylmar, CA 91342 (Mail: PO Box 9203, Sylmar, CA 91392); (818) 364-1611; www.spearsmfg.com

K. CHECK VALVES (2-INCHES AND GREATER)

- 1. Check valves 2-inches [50 mm] and higher in size must either be a "swing check" type or the "wafer-style" torsion spring design.
- 2. Materials of construction must be Stainless Steel, including body, disc, arm, stem, shaft, spring, bushing, and seat ring.
 - a. Note thermoplastic water velocity limitation as indicated above
- 3. The disk must sit, compress tightly, and secure positive closure to prevent backflow.
- 4. The valve seat and any other wetted part must be of a material rated for continuous chlorinated-water service.
- 5. Any wetted elastomer must be EPDM or VITON.
- 6. The valve design must allow for replacement or removal without disassembly of the adjacent flanges.
- 7. The Basis of Design (pre-approved equals):
 - a. "Ritepro" by Bray, Model 210, ASME 150, with stainless steel body and seat
 - b. "Dual-Disc type" by Val-Matic in stainless steel Grade 316.
 - 1) Pre-Approved Alternate: "Dual-Disc type" by Val-Matic in Ductile Iron ASTM A536, Grade 65-45-12 with BUNA-N Resilient Seat Molded to Body with mandatory Fusion Bonded Epoxy (FBE) Coating

L. POTABLE WATER ISOLATION VALVES

- 1. Isolation valves for potable water service at street pressures less than 150 psi [1.03 mPa] must be of bronze construction and either "ball" or "gate" design.
- 2. Valves must have glass-reinforced Durafill valve seats rated for potable water service.
- 3. The valve ball or disc must be hard chrome-plated brass. The valve must be bottom-loaded with a pressure retaining stem.
- 4. The valve must be rated "bubble-tight" service in continuous isolation service at 400 psi [2.76 mPa] WOG (non-shock).
- 5. Valves must comply with all applicable requirements and conform to federal specification WW-V-35B, Type II, Style 3, Class A.
- 6. The maximum water velocity allowed through plastic-type valves must be 5.0 fps [1.524 mps]. Valves located in positions with water velocities that exceed 5.0 fps [1.524 mps] must be metallic and manufacturer rated for those flow velocities.
- 7. The Basis of Design:
 - a. Series B-6000 or equivalent by Watts Regulator Company; Lawrence, MA 01842 (617-688-1811).

M. MOTORIZED CONTROL VALVES

1. Motorized control valves must be furnished as a complete assembly by a single source and be pre-assembled and factory tested before delivery.
2. The valve must be bi-directional motion and rated for 100 psi [689.5 kPa] minimum continuous pressure services.
3. The valve must be of the "butterfly" type suitable for continuous throttling applications.
4. The valve body must be wafer style and meet ANSI Class 125/150 flange standards. Valve neck length must be sufficient to allow for flange clearance. The valve body must have an integrally cast top plate for direct flush mounting of an electric motor actuator without brackets or adapters.
5. The valve seat must be field replaceable and must be designed to adequately isolate the valve body, stem, and journal areas from the liquid media. The outside diameter of the valve disc must be such that, when opened, it must not interfere with adjacent piping.
6. The stem must be one-piece. The disc, shaft, and stem must be connected by a Grade 316L stainless steel torque plug or disc screw. This connection must provide positive engagement preventing blowout of the one-piece stem, must maintain a leak-proof, shake-proof-connection, and allows for quick, easy disassembly.
7. Materials of construction must be as follows:
 - a. The valve body must be cast aluminum with Rilsan Coating on all interior and exterior surfaces.
 - b. The seat must be EPDM or VITON.
 - c. The disc must be stainless steel.
 - d. The shaft and stem must be Grade 316L stainless steel.
 - e. All hardware (bolts, nuts, washers, and related metallic components) must be stainless steel, grade 316L.
8. The electric actuator must consist of a permanent split-capacitor, a reversible-type electric motor that drives a compound epicyclical gear.
9. A handwheel with a de-clutch lever must be provided to not rotate during electrical operations.
10. The valve actuator must have visual, mechanical position indication, readable from 12-feet [3.5 m], showing the output shaft and valve position. The unit can mount directly to butterfly valves without brackets or adapters.
11. The actuator must have an integral terminal strip that must secure wiring to power supplies through the conduit. The cable entry must be with two 1-inch [25 mm] NPT threaded connections. The actuator must be rated for continuous duty and must be constructed to withstand high shock and vibrations without failure. The actuator must have a self-locking gear train, which is permanently lubricated at the factory. The actuator must be fitted with two adjustable factory-calibrated mechanical torque limit switches of the single-pole, double-throw type.
12. The motor must be equipped with overload protection. The actuator housing must be hard-anodized aluminum for extensive environmental protection and be rated to NEMA-4X standards. The actuator must include mechanical travel stops, which is adjustable to 15 degrees in each 90-degree rotation direction. The mechanical travel stops must be adjusted in the field to obtain the desired reduced flow when the valve actuator is energized to a position as closed. The actuator must include two adjustable travel limit switches with electrically isolated contacts.

13. The electrical motor must be rated for 120VAC, 60 hertz, and single-phase electricity. The Valve Manufacturer must select the actuator size to provide sufficient closing and opening torque to rotate the valve 90 degrees in no more than 20 seconds. The valve is at 100% flow and pressure conditions.
14. Unless otherwise specified, the actuator must be by Dominion or Val-Matic or a pre-approved equal. www.neptunebenson.com

N. ELECTRIC SOLENOID VALVES

1. Electric solenoid valves must be furnished as a complete assembly by a single source and be pre-assembled and factory-tested before delivery.
2. The valve must be of the plunger or linear motion type and be rated for 100 psi [689.5 kPa] minimum continuous pressure service at water temperatures not exceeding 125° F [51° C]. The valve must be suitable for continuous isolation service without leakage under the conditions specified.
3. Wetted surfaces must be suitable for continuous use in mildly chlorinated and saline content water (associated with saline chlorine generators) typically of pool applications.
4. Materials: Stainless steel or PVC. The valve must have NPT connections in the sizes specified. The valve body must have an integral top plate for direct flush mounting of an electric solenoid actuator without brackets or adapters.
5. The electric solenoid actuator must have an integral terminal strip or wire leads, which through conduit enters, must secure wiring to power supplies. The cable entry must be utilizing 0.5 inches [13 mm] NPT threaded connection. The actuator must be rated for continuously energized duty and must be constructed to withstand high shock and vibrations without failure.
6. The actuator housing must be rated for extensive environmental protection to at least NEMA 4X standards unless noted otherwise. The electrical actuator must be rated for 120VAC, 60 hertz, and single-phase electricity. The actuator size must be matched to the valve size to provide positive closing and opening while flowing water at 100% pressure.
7. The valve must be closed when the solenoid is deenergized (and 100% open when energized). The solenoid valve must be "quick-acting" with a total closure time not to exceed one (1) second.
 - a. Specified solenoid valves must operate on a 4-20 ma signal to allow a valve operation at variable settings such as valves in the surge and reservoir tanks to enable the desired water level within that tank.
 - 1) Such valves must be controlled by specially equipped water level sensors and the related control panel or chemical controller when equipped by the manufacturer with the appropriate input/output circuits.
8. The selected solenoid valve must be equivalent to or better than ASCO, ASAHI, Magnatrol, or pre-approved equal.

O. MODULATING (DIVERSION) FLOAT VALVES

1. Modulating / diversion float valves - vertical must be flanged float valves with double float and pivoted arms with guides. The entire assembly must be designed and fabricated for submerged service.

2. Construction must be either stainless steel or PVC/Polypropylene and equipped with Type 2, Sch. 80 PVC van stone flanges. Floats must be adjusted in the field for the normal operating water level in the collector/reservoir/surge tank.
3. Modulating valve units must be equipped with chemical resistant gaskets/seals that must prevent air intrusion into the pump suction piping.
4. The Basis of Design:
 - a. Model "Dual-Float" (in the sizes noted within the Drawings) as distributed by Neptune Benson.

P. BACKWASH VALVES

1. The Basis of Design:
 - a. 2-inches [50 mm] 100% -port, high-flow, manual backwash multiport valve assembly suitable for operation with a corresponding Pentair filter tank unit.
 - 1) The valve must have no more than 1.5 psi [10.3 kPa] pressure drop when flowing 100 gpm [379 L/min] of water.
 - 2) The valve must have unrestricted 2-inches [50 mm] inlet and outlet ports and allow operator selection of flow direction for various operational modes.
2. The valve must be of substantial Type 3 CPVC body construction. The valve must be rated for continuous operation to 50 psi [344.7 kPa] operating pressure.
3. Large (more than a 100 GPM [378 LPM] flow rate) automated sand filter systems must be equipped with the factory-supplied automatic valves.

Q. OTHER SPECIFIED VALVES

1. Unless otherwise specified, the valves must satisfy the applicable general requirements of the Specifications for the specified duty.
2. Other chemical valves are also specified in "Chemical Equipment."
3. Specified valves are "manual" unless electric, motorized, or pneumatic valves are explicitly specified within the Drawings.
4. Valves specified for chemical duties must be rated appropriately for peak chemical concentrations expected after the injection point.
5. Metallic-type valves must be equipped as follows:
 - a. Factory primed then Fusion Epoxy Coating or approved equal
 - b. EPDM or VITON Seals
 - c. Stainless steel stems and shafts
 - d. Stainless steel fitted

2.21 NOT USED

2.22 NOT USED

2.23 MAINTENANCE, SERVICE, TESTING, & RELATED EQUIPMENT

A. GENERAL

1. Provide commercial-rated equipment.
2. Observe and follow manufacturer's instructions & recommendations
3. Refer to the Drawings' Equipment Schedules for exact models specified.

B. MAINTENANCE & SERVICE EQUIPMENT

1. Maintenance handles & poles:
 - a. 1-piece 1.25-inches O.D. [32 mm] fiberglass handles with quick-change adapters to connect cleaning equipment
2. Vacuum hose:
 - a. Heavy-duty rated with integrally molded cuffs
 - b. 2-inches [50 mm] diameter x 50-feet [15.24 m]
 - c. Materials contain UV inhibitors
 - d. Color: White/Black
 - e. Warranty: 4 years
3. Wall Brush:
 - a. Heavy-duty firm & non-metallic bristles
 - b. Curved, 24-inches [610 mm] long
 - c. Include quick connector for easy adaption to pole
4. Vacuum head:
 - a. Commercial Flex-O-Vac vacuum head
 - b. 24-inches [610 mm] wide x 7-inches [178 mm] deep
 - c. Dual vacuum connectors to a single 2-inches [50 mm] hose connection

C. ROBOTIC AUTOMATIC POOL VACUUM CLEANER

1. If listed and specified in the Drawings, provide the Robotic Automatic Pool Vacuum Cleaner; otherwise, disregard.
2. Components & Materials
 - a. The pump's suction power must be a minimum of 13,208 gallons/hour [50 CuM/hour].
 - b. Onboard sensors must include a gyroscope, tilt sensors, and infrared proximity
 - c. Rotating brushes must be PVC or PBC (or a combination of both)
 - d. Stainless steel outer casing
3. Programming
 - a. Equipped with multiple pre-programmed cleaning tracking scenarios
 - b. Includes an eight-function remote control
4. Cleaner Bags
 - a. Filter bag options must include the following micron choices:
 - 1) 105, 250, or 1,000
5. Ease of maintenance
 - a. The pump must be accessed, repaired, and maintained on the pool deck without tools.
6. Data:
 - a. Cleaner width: 28.7-inches [73 cm]
 - b. Weight in-water / out of water: 8.81 pounds [4 kG] / 60 pounds [27.2 kG]
 - c. Trolley: St. Steel with cable reel

- d. Power: 120/220 VAC / 24 VDC
- e. Cable Length: 131-ft [40 m]
- f. Pump: 14,530 gal/hour [55 cu m /hour]
- g. Cleaning Velocity: 5,600 sf / hour
- h. Filtration capacity: 8.37 pounds [3.8 kG] sand
- i. Walls & obstacles detection: 2 infra-red sensors and tilt sensor
- j. Water Operating Depth (min.): 15-inches [38 cm]

7. The Basis of Design:

- a. Enduro-TurboClean XL; US Exclusive Distributor: CES, 2 Jupiter Park Lane, Suite 1, Jupiter, FL 33458, USA; 800.940.1557; WWW.CESWaterQuality.com

D. CHEMICAL TESTING

1. Provide testing lab kit for:

- a. Free Available Chlorine: 1- 10 ppm
- b. Total Available Chlorine: 0 – 3 ppm
- c. pH – 6.8 – 8.4 ppm
- d. Acid & base demand
- e. Calcium Hardness (CAH)
- f. Total Hardness
- g. Cyanuric Acid (CYA)
- h. Copper and Iron
- i. Reagents for 24 months of testing

- 2. The Basis of Design: Taylor Professional Complete Chlorine Testing Lab; model #56-300 by Recreonics; www.recreonics.com

2.24 NOT USED

2.25 NOT USED

2.26 NOT USED

2.27 NOT USED

2.28 NOT USED

2.29 MISCELLANEOUS EQUIPMENT

A. EMERGENCY EYEWASH STATION

- 1. Provide one (1) emergency eyewash station and drench shower (in each chemical equipment room)
- 2. The Basis of Design: Bradley Plumbing Fixtures; 414-251-6000. Refer to the Drawings for the specified model number. There are no known equal.

B. PERIMETER OVERFLOW SYSTEM - PARALLEL GRATING

- 1. Grating over the trench at the zero-entry and infinity sumps must be parallel-type by Daldorado LLC. Ph: (888) 509-8128, 4327 Arnold Ave, Naples, FL 34104; www.daldorado.com with the following Specifications.

2. The grating must be formed from molded-PVC sections: modular, interlocking sections, UV stabilized, and certified NSF-50.
 - a. The top-section must have a raised-herringbone design and certified to IBC Classification C for Wet-Barefoot inclining-platform (ramp) test for swimming pool-surroundings and communal shower rooms.
 - b. Grating must be 0.47" [12mm] wide & include the outside depth of 1.0" [25.4mm] with a middle-depth of 1.83" [46.6mm] for load strength requirements.
 - c. The grating must be certified per ANSI/AS3996 Class A for covers and grates with a load exceeding 10kN (2,248lb).
 - d. The spacing between the grating bars must not exceed 0.315" (8mm) to comply with IBC child finger/toe entrapment guidelines.
 - e. The grating-surface bars must be continuously-parallel to the pool wall, and with the gap, provide a minimum 40% open space per foot for unrestricted water flow.
 - f. Fasteners must be SS-Type 316 and be provided by the manufacturer.
 - g. The grating-width must allow the touchpad's insertion holding brackets between the grating and the gutter lip.
 - h. All inside & outside corners and custom radii sections under 3-feet inside diameter must be custom fabricated and strengthened by the manufacturer.
 3. The Architect/Owner must select the grate color.
 - a. Colors are available in white, bone, and gray.
 4. The grating must have a minimum 10-year manufacturer's warranty.
- C. HIGH-STRENGTH MOLDED FIBERGLASS GRATING & SAFETY RAILS
1. Floor grating over each indoor collector/reservoir/surge tank must be GRIDWALK square mesh grating by American Grating, LLC; 1191 Center Pointe Drive; Henderson, NV, 89074 (1-800-990-4783) with the following Specifications.
 - a. Be provided with a grating thickness of at least 2-inches [50 mm]. Mesh must be a maximum of 1.5-inches [40 mm] square on a regular pattern with a bar width of at least 0.32 inches [8.1 mm].
 - b. Gridwalk grating sections:
 - 1) Capable of withstanding a consistent load of 109 pounds per square feet [532 kG per square m] over a 36-inches x 36 inches [915 mm x 915 mm] square section without exceeding a center point deflection of 0.080 inches [2 mm].
 - 2) Capable of withstanding a concentrated center load of 200 pounds per square feet [976 kG per square m] of grating on a 36-inches x 36 inches [915 mm x 915 mm] section without exceeding a center point deflection of 0.213 inches [5.4 mm].
 - 3) Must be field-fitted to the specified size, as shown in the Drawings per the manufacturer's instructions.
 - c. Cut out sections of the grating to allow the auto-fill system, vacuum discharges, and other utilities to spray into each tank.
 - d. The area to be covered with this fiberglass grating must be divided into individual sections so that each section does not exceed 4-feet [1.2 m] in width.

- e. Provide structural pultrusion floor supports as needed if This Engineer deems the deflection of the grating to be unacceptable. Such support and bracing must be provided as part of the Base Bid.
 2. Outdoor located collector/reservoir/surge tanks must have a lockable lid enclosure.
 3. Permanent railing system for elevated platform fall protection. (SRC Permanent Rail) at the perimeter edges of the pump pit (sump).
 - a. Basis of Design:
 - 1) Safety Rail Company, LLC., 4244 Shoreline Drive, Spring Park, MN 55384; Toll-Free Tel: 888-434-2720; Tel: 952-594-3508; Fax: 888-471-4931; Email: sales@safetyrailcompany.com Website: www.safetyrailcompany.com
 - b. Structural Load: 200 lb. [90.7 kg], minimum, in any direction to all components per OSHA Regulation 29 CFR 1926.502.
 - c. Railing height for Face and Flush Mount brackets are 48-inches [1219 mm]. When Face or Flush Mount brackets are installed level with the walking surface, it yields a railing height of 42-inches [1066 mm] above the walking surface.
 - d. Railings: 1-5/8 inch [1 mm] O.D. hot rolled pickled electric weld tubing, free of sharp edges and snag points
 - e. Mounting Style: Flush Mount brackets – bolted to top corner of wall or pit, railings removable
 - f. Product Origin: Railings and Bases are specified as 100% made in the USA. The manufacturer must provide steel mill and foundry certificates for verification upon request.
 - g. Quality/Standards Certifications: Manufacturer must be American Welding Society welding qualified for Welding Standards AWS D1.1 & AWS D1.3 Third-party qualification documentation required before shipment
 - h. Finishes: Hot Dipped Zinc Galvanized; Color: Safety Yellow
- D. WATER FILL SYSTEM - AUTOMATED
1. Each pool must be fitted with an automatic water level control system.
 2. The water level control and fill system must include a manual fill valve (as sized on the Drawings) arranged in parallel with the automatic fill valve (sized on the Drawings). Install an additional isolation valve on the potable water inlet line for safety.
 3. Valves exposed to municipal-supplied water pressure must be rated for safe drinking water pressures up to 125 psi [861.8 kPa]. Maintain a minimum of 4-inches [100 mm] air gap from the municipal's water supply pipe terminus to each water feature's maximum water level and pool (as measured in the collector/reservoir/surge tank).
 - a. The water connection must be via a listed, pre-approved backflow preventer system, as noted herein.
 4. The potable water fill system must comply with local and state codes and requirements.
 5. Provide a water hammer arrestor as specified.
 6. Provide a pressure limiting device if the pressure of the supply pipe is higher than 60 psi.
 7. Pre-approved automated water-fill systems include:
 - a. Basis for Design: The feature and pool's water level control system for:

- 1) Aquaworx fabricated fiberglass tanks must be from the ATLEV family (sizes vary) by Aquaworx Inc.; 10450 66th St N #3, Pinellas Park, FL 33782 (1-888-426-8511).
- 2) Vak-Pak fabricated fiberglass tanks must be from the CT family (sizes vary) by Vak Pak, Inc., P.O. Box 3264, Jacksonville, FL 32206; 800.877.1824 or 904.353.4403; E:: info@vakpak.com

E. COMPRESSED AIR SYSTEMS & ACCESSORIES

1. Air compressor:
 - a. Provide air compressors, coolers, drying systems, oil removal filters, separator vessels, sensors, screens, receiver tanks, related valves, check valves, gauges, drains, moisture removal units, and controls PLC's.
 - b. Air compressors must generate the target air supply and noted pressures and include the following mandatory, minimum accessories:
 - c. Variable speed drive and internal automated operating controls
 - d. Remote monitoring reporting features
 - e. Air, oil, and water filters
 - f. Water-cooled units provided unless otherwise noted
 - g. Stainless steel heat exchangers
 - h. Reverse osmosis system with internal booster pump
 - i. Water pump (for internal compressor circulation and cooling)
 - j. Integrated refrigerant dryer
 - k. Sound insulated canopy
 - l. Oil-free output air supply
2. Receiver tank
 - a. Designed and constructed per ASME Section VIII Div-I Code for compressed air storage use.
 - b. Epoxy-fused coatings – interior and exterior
 - c. Stainless steel fittings
 - d. Automated controls
 - e. Gauges, flow meters
 - f. Communication protocols with an air compressor
3. After-cooler
 - a. Water-cooled unit (integral with an air compressor)
 - b. Gauges, valves, controls
 - c. Safety guards to prevent heat injury
4. Gauges, valves, the rate of flow indicators, and monitoring package
5. The Basis of Design:
 - a. Air Compressor: Atlas Copco, Model AQ-xx, 10-Bar, 800-732-6762; www.atlascopco.com
 - b. Receiver Tank: Model 660 gallons, vertical air receiver tank, 165 PSI, Manchester Tank, 1000 Corporate Centre Drive, Suite 300, Franklin, TN 37067; 800-399-5628; www.mantank.com
 - c. After-Cooler: Integral with Air Compressor

F. FLOOR ACCESS DOORS

1. Provide the Drawings relating to the vault access door Type JD-AL; refer to the Drawings for the door sizes.
 - a. Length denotes hinge sides.
 - b. The floor access door must be double leaf and pre-assembled from the manufacturer.
2. Performance Characteristics
 - a. Covers: Must be reinforced to support a minimum live load of 300 psf (1464 kg/m²) with no more than a maximum deflection of 1/150th.
 - b. The covers' operation must be smooth and easy with controlled operation throughout the opening and closing arc.
 - c. The operation of the covers must not be affected by temperature.
 - d. The entire door, including hardware components, must be highly corrosion resistant.
 - e. Covers: Must be 1/4-inch (6mm) aluminum diamond pattern.
 - f. Frame: The channel frame must be extruded aluminum with bend down anchor tabs around the perimeter.
 - g. Hinges: Must be specifically designed for horizontal installation and must be through-bolted to covers with tamper-proof Type 316 stainless steel lock bolts and must be through-bolted to the frame with Type 316 stainless steel bolts and locknuts.
 - h. Drain Coupling: Provide a 1-1/2 inch [38 mm] drain coupling located in the right front corner of the channel frame.
 - i. Lifting mechanisms: The manufacturer must provide the required number and size of compression spring operators enclosed in telescopic tubes to provide smooth, secure, and controlled cover operation throughout the entire arc of opening and limit as a check-in retarding the downward motion of the covers when closing. The upper tube must be the outer tube to prevent moisture, grit, and debris inside the lower tube assembly. The bottom tube must interlock with a flanged support shoe fastened to a formed 0.25-inch [6 mm] gusset support plate.
 - j. A removable exterior turn/lift-handle with a spring-loaded ball detent must be provided to open the cover. Provide flush, gasketed, removable screw plugs to protect the latch release.
 - k. Safety Ladders with an extendable safety post must be provided with each floor access door.
 - l. Hardware:
 - 1) Hinges: Heavy forged Type 316 stainless steel hinges, each having a minimum 1/4-inch (6mm) diameter Type 316 stainless steel pin, must be provided, and pivot covers do not protrude into the channel frame.
 - 2) Covers must be equipped with a hold-open arm, which automatically locks each cover in the open position.
 - 3) Covers must be fitted with the required number and size of compression spring operators. Springs and spring tubes must be Type 316 stainless steel.
 - 4) A Type 316 stainless steel snap-lock with a solid handle must be mounted on one cover's underside.
 - 5) Hardware: Must be Type 316 stainless steel throughout.

3. Finishes: The factory finish must be mill finish aluminum with a bituminous coating applied to the frame's exterior.
4. The Basis-of-Design Manufacturer: Type JD-AL Access Door by The Bilco Company, P.O. Box 1203, located in New Haven, CT 06505, 1-800-366-6530, Fax: 1-203-933-8478, Web: www.bilco.com.

G. POOL COVER & STAINLESS-STEEL MOTORIZED STORAGE REEL

1. A high-strength cover must be capable and ready for heavy-duty use in punishing environments. Must be abrasive resistance, strength, robust seam configurations, and super-reinforced ends.
 - a. When a pool cover is specified, it must be secured around the entire pool perimeter. It can support a live load of an adult person, or the pool area must be made inaccessible to unauthorized persons when the cover is in use.
2. The following pool cover equipment features are required:
 - a. Load dispersing PVC plate.
 - b. Heavy-duty, proprietary composite vinyl fabric.
 - c. UHMW-PE dowel with solid-braided polyester cord.
 - d. Long-lasting stainless-steel grommets throughout.
 - e. Double lockstitch "Quadra Seams" construction with heavy-duty UV-resistant polyester thread. Seams must be sewn parallel to load direction for enhanced durability
 - f. Double-layer fabric encapsulation.
 - g. Exclusive and proprietary UV-resistant LDPE coating 'Ultrisorb'.
 - h. Clear UV-resistant HDPE scrim.
 - i. 2 pcf density closed cell, cross-linked, EVA enhanced polyethylene foam.
 - j. Weighted anchor edge with extruded UVR flex vinyl.
3. The Storage Reel must be stainless-steel and equipped with an electrical power pack for more comfortable operation.
 - a. Model UNA's Product Details to incorporate the following required features:
 - 1) On-device or remote-control operation
 - 2) Rechargeable battery-power
 - 3) Heavy-duty stainless-steel construction
 - 4) Integrated directly into one-tube storage reels
 - 5) Capable of storing three 15' by 75' long cover panels on single-tube reel
4. Basis of Design: T-Star Energy Saver Pool Cover, Distributor: CES, 2 Jupiter Park Lane, Suite 1, Jupiter, FL 33458, USA; 800.940.1557; WWW.CESWaterQuality.com

2.30 NOZZLES & RELATED EQUIPMENT

A. GENERAL

1. Applicable to all metallic components and equipment without exception
 - a. Each nozzle and specialty metallic component must be fabricated from Stainless Steel, Grade 316L (or better) unless expressly noted herein or within the Drawings.

- 1) The manufacturer(s) of stainless-steel components must provide their products passivated and delivered with no carbon/iron particles.
 - a) Passivation is a non-electrolytic process generally using nitric or citric acid, which removes free iron from the surface and forms an inert, protective oxide-layer that, in turn, renders the stainless-steel more rust-resistance due to lack of iron-reactions with the atmosphere.
2. Supply with all nozzles with flow straighteners, swivel connections, and UL-Listed bonding/grounding lugs (or for provisions for bonding/grounding) as specified. Refer to process flow diagrams for model references.
 - a. The specific materials of construction for each nozzle are critical and must not be substituted.
 - b. Nozzles must be factory-assembled and tested before shipment.
 - c. Incorporate a bonding provision with a UL-Listed grounding lug provided on the nozzle body.
3. The Basis of Design for all fountain & water feature equipment:
 - a. Fontana Fountains: 40 Gracechurch Street, London, EC3V 0DN, United Kingdom; +44 20 7193 8975; sales@fontanafountains.com
4. Fountain equipment manufactured in China, India, and Southeast Asia is prohibited explicitly from consideration or use.

B. STATIC NOZZLES

1. Refer to the Drawings' Equipment Schedules for the static nozzles' manufacturer(s). Refer to the nozzle descriptions herein.
 - a. Submit the following when requesting equivalent products:
 - 1) Flow rates and pressures must be in exact compliance and equivalent with the initially specified component (to verify that the pumps specified must be matched perfectly with the total flow and pressures).
 - 2) Dimensions must match the specified component (to check that the nozzles must fit within the space provided).
 - 3) Water spray geometry and performance of the nozzle must be equivalent to the specified unit.

C. SEQUENCE DEVICES - AUTOMATED

1. The product specified in the Equipment Schedules sequence device must be a water level independent sequencing nozzle assembly, consisting of a submersible pump with VFD control, as shown in the Drawings and supplied as a 100% assembly.
 - a. Sequencing is mandatory for each nozzle unless identified as a "non-sequenced" unit.
 - b. The sequencing device must be a water level independent sequencing nozzle assembly, consisting of a submersible pump with VFD control, as shown in the Drawings and supplied as a 100% assembly:
 - 1) Submersible Grundfos Pump: Removable service. Including 8/4 submersible cable (in length specified to allow connection to the data junction box).

- 2) 50/60 Hz AC signal and common for sequencing device
- 3) A designated industrial ground fault circuit interrupter (within the Control Panel) must be provided with each submersible pump.

2.31 UNDERWATER LIGHTS & RELATED EQUIPMENT

A. UNDERWATER JUNCTION BOXES

1. Junction boxes and fasteners must be constructed as specified and equipped with suitable cover gaskets providing a water-proof enclosure.
2. Each junction box must have a bonding/grounding provision with a UL-Listed bonding/grounding lug on the metallic-body.
3. The size and quantity of conduit integral outlets with their cord-seals must be fabricated to comply with the Drawings.
4. Provide the re-enterable potting in each underwater junction box to complete encapsulation of all wires and wire connectors/joints to prevent water contact or water intrusion to the conductors. Without exception, junction boxes must be provided with a re-enterable potting compound encapsulating all conductors, splices, and connections.
 - a. Only potting compounds certified by the junction box manufacturer must be authorized for use.
 - b. The Basis of Design for Re-Enterable Compound:
 - 1) 3M™ Scotchcast™ 2123; 3M Electrical Markets Division; 6801 River Place Blvd.; Austin, TX 78726-9000; 800.245.3573; www.3M.com/electrical
5. Multiple 0.50 inch [12 mm] PVC socket connection(s) for submersible cable in wet conduit.
6. The manufacturer must certify the cord seals, seals & gaskets, potting compound materials, and junction box assembly as suitable for permanent immersion into chlorinated water, 7,000 ppm of saline water (as associated with saline-based chlorine generators) and be leak-free.
7. The Basis of Design for Junction Boxes:
 - a. Fontana Fountains: 40 Gracechurch Street, London, EC3V 0DN, United Kingdom; +44 20 7193 8975; sales@fontanafountains.com

B. SLEEVE FITTINGS & FASTENERS

1. Sleeve fittings and fasteners must be complete units and be constructed as specified.

C. WATER FEATURE UNDERWATER LIGHTS

1. General:
 - a. The cabling, conductors, and wiring located in under-deck, underground, and underwater conduits must comply with wet-rated requirements of NEC Article 300.50 (Underground Installations) and NEC 310.10 (Wet Locations).
 - 1) Note: Under-Deck, underground, and underwater cabling, conductors, and wiring must be UL-listed (or an approved equivalent) as suitable for under-deck, underground, underwater, and Wet locations
 - 2) Each underwater light must have a grounding provision with a UL-Listed grounding lug on the body (or equivalent agency listing requirements).

- b. Unless expressly otherwise noted:
 - 1) Feature Underwater LED lights must be 100% color-changing RGBW and reproduce a minimum of 16,000,000 individual colors with the LED's covered by optically clear lenses.
 - 2) 512DMX technology (to program this lighting system) is required.
 - 3) Each LED light must come intact with control boards, programming software, power supplies and be provided in a pre-assembled enclosure as indicated in the Drawings.
 - 4) Each LED light must have an expected lifespan of approximately 50,000 hours' minimum at nominal ratings.
 - 5) Each LED light assembly must be serialized and traceable to production tests.
 - c. The Feature LED light manufacturer must provide written certification that the LED lights and their controls are of the latest technology available and rated for RGBW capabilities.
 - d. Constructed with heavy-duty UV-resistant materials and metallic components subject to submerged water conditions must be Stainless Steel Grade 316.
 - e. IP 68 Rating allows installation in any environment (including complete submersion in chlorinated water). The specific manufacturer must have authorized this product to be in a submerged water condition with a chlorine exposure of up to 5 Parts per Million (PPM).
 - f. The manufacturer must list 5 installations (minimum) of this product in a submerged application environment. The Contractor must include contact information (name, company, the name of the project, phone number, and email addresses) of the on-site operators to verify these submerged LED strip lighting units' suitability.
 - g. Incorporate a simple installation process with an IP68 connector and brackets identified by the manufacturer for authorized submerged applications. Rigid or flexible with numerous mounting and connection methods must be first authorized by the manufacturer. The manufacturer must provide grounding connections at specified intervals.
 - h. Available in various profiles and light output to comply with and match the details and requirements of this water feature project.
 - i. All exposed ground lugs and bare copper wire must be coated as per 2.31.D.7.
- 2. Feature underwater lights, light housings, niches, rock guards, brackets, fasteners, freestanding support devices, and stands must be complete units and be constructed as specified.
 - a. Supply supports/stands with vertical adjustments.
 - b. Capable of a 20-degree aiming adjustment (from absolute vertical)
 - c. Have a bonding/grounding provision with a UL-Listed bonding/grounding lug.
 - 3. Each feature LED light unit must be provided with a low-water cutoff device or controlled via an approved low-water-level sensor.
 - 4. Each electrical connection must be potted and made waterproof per the manufacturer's instructions & recommendations.

- a. Supply each underwater light customized to be equipped with sufficient cord length to connect to the related underwater junction box when routed on the Water Feature floor or within the below-grade conduits as indicated on the Drawings.
 - 1) Upper ponds connected via wet conduits to junction boxes at lower elevations must be demonstrated to be waterproof.
 - b. 18/5 STW submersible cable (Type ST or SO)
 - 5. The LED lamp(s) must be UL listed for fountain (Water Feature) applications.
 - a. Each lamp must be protected with a Class 'A' CFGI 256*256*256 as outlined in NEC.
 - b. Each lamp must have an independent Neutral routed back to the Lighting control panel.
 - c. The use of Common Neutrals or ganging of neutrals is not acceptable.
 - 6. Unless otherwise explicitly stated, the LED color-changing lights must be 12VDC, in the wattage noted, DMX addressable, and equipped as follows:
 - a. Optically clear lenses of convex cast cut glass, tempered, and heat resistant
 - b. Polarity reversible sensors
 - c. Capable of indicating if the DMX is not active or if the DMX polarity is reversed.
 - d. Underwater rated cable – 18/5 STW or 5X1mm² Ho5RN-F (SOOW) submersible for lengths indicated in the Drawings
 - e. Individual LEDs must be mounted on an aluminum mounting plate for highly efficient heat dissipation and then attached to the housing using thermally conductive heat transfer epoxy.
 - f. Tested using pressure decay at 15 PSI (1.1 bars) and certified by the manufacturer. The pressure decay system can detect 0.1 Pascal (0.000145 psi)
 - 7. Underwater niche lighting
 - a. Deep Niche LED light fixture must include rock guards, and related hardware must comply with the following:
 - 1) Stainless Steel Type 316 or better
 - 2) Multiple 0.50 inch [12 mm] PVC socket connection(s) for submersible cable in wet conduits. The Contractor must demonstrate each assembly to be waterproof.
 - 3) Have a bonding/grounding provision with a UL-Listed bonding/grounding lug.
 - 4) Be provided with a scheduled wattage, smooth dimming, and high-res color mixing.
 - 5) Incorporate a low EMI and fully programmable with the standard DMX-512A control signal.
 - 6) Capable of operating in a synchronized mode and switchable between pre-programmed shows using a show main switch.
- D. SWIMMING POOL & IWF LED UNDERWATER LIGHTS
- 1. General:
 - a. The cabling, conductors, and wiring located in under-deck, underground, and underwater conduits must comply with wet-rated requirements of NEC Article 300.50 (Underground Installations) and NEC 310.10 (Wet Locations).

- 1) Note: Under-Deck, Flush-at-Deck, underground, and underwater cabling, conductors, GFCI's, and wiring must be UL-Listed (or an approved alternate) for Underground and Wet locations
 2. Mount each LED underwater light in a stainless-steel Type 316 (or better) or an approved non-metallic wet niche.
 3. Provide LED light unit with a low-water cutoff device.
 - a. Exception: If the LED underwater light is rated for continuous use in "dry" and "wet, submerged" conditions, this requirement must not apply.
 4. Each LED light must be shipped with 95-feet [28 m] length wet-rated underwater cable unless specified otherwise.
 5. Each light assembly must include a low-voltage power supply/transformer to operate the fixture at more than 15 volts and must be installed per the manufacturer's specifications and be approved for such use by UL or NSF.
 - a. Low-voltage power supplies/transformers enclosures must be a NEMA 3R rating.
 6. Have a bonding/grounding provision with a UL-Listed grounding lug.
 7. The potting kit compound is required at all underwater bonding/grounding lugs, bond/ground conductors, and splices must be coated/encapsulated with one of the below-listed materials.
 - a. The material Potting Compound for Encapsulation must be packaged in the two-part plastic composite closed mixing pouch. Mix the resin within the closed mixing-container/pouch by merely separating the barrier between the two parts of the package and working the contents back and forth within the bag.
 - b. The Basis of Design:
 - 1) 3M Scotch-cast #2136 potting kit, 3M Electrical Markets Division, 6801 River Place Blvd., Austin, TX 78726-9000, 800.245.3573; www.3M.com/electrical
 - 2) AquaBond ABP-1000 potting kit; AquaBond, LLC, 6444 E. Spring Street #275, Long Beach, CA 90815-1553, 714.961.1420; sales@aquabond.com
- E. UNDERWATER LIGHTING POWER SUPPLIES / TRANSFORMERS
1. Outdoor pool illumination/lighting: If night swimming is to be approved, underwater lighting must provide at least 0.5 watts per square foot of the pool basin's water surface area, and outdoor wet deck and pool surface illumination of 3 Foot-Candles.
 - a. Exception: Indoor pool lighting: Underwater lighting must be a minimum of 0.8 watts per square foot of pool surface area.
 - b. Exception: Wading pools and Water Activity Pools are exempt from underwater lighting requirements (when the depth is less than 3-feet) but must have lighting installed for night use of 10-footcandles [1000 lux] if indoors or 6-footcandles [60 lux] for outdoor night-use. Such illumination must be provided over the pool water surface and the pools' wet deck surfaces.
 2. Power Supplies / Transformers for underwater pool lighting must be rated at 120 VAC primary and 12VAC secondary for 60-hertz continuous operation, 3 amps, and 300 watts.
 3. Power ratings:

- a. LED 45 watts white (which is equivalent to 300 watts incandescent) minimum for pool underwater lights.
- b. LED 26 watts white (which is equivalent to 100 watts incandescent) minimum for spa underwater lights.
4. The power supplies/transformers must be mounted in a waterproof exterior enclosure and suitable for above-grade, outdoor mounting.
 - a. Locations within 1 mile of coastal regions: stainless steel NEMA 4 weatherproof rating
 - b. The power supply/transformer must be of the two-winding type, internally fused for overload protection.
 - c. Three taps must be provided to safeguard proper voltage when operated within allowable line loss limits.
 - d. Two separate wiring compartments must provide isolation between primary and secondary leads.
 - e. Power supplies/transformers must be UL-rated, GFCI Class "A," and approved for pool underwater lights.
 - f. Have a grounding provision with a UL-Listed grounding lug.

2.32 WATER TOYS, WET PLAY, & RELATED EQUIPMENT

A. GENERAL

1. Provide water toys and wet play per the Drawings.
2. Follow and observe the manufacturer's requirements.
3. Fiberglass flume components: Refer to the selected wet play, water toys' vendor to provide such components.
4. Flume support, tower, and stair system: Refer to the selected wet play, water toys' vendor to supply such components.
5. Have a bonding/grounding provision with a UL-Listed bonding/grounding lug.
6. The filtration system must be capable of returning the pool water turbidity to 5/10 NTU within 8 hours or less after peak bather load.

B. COMPLETE BUILD SCENARIO

1. The water toys, wave-generator, lifeguard & safety planning, and wet play must be a Complete Build Scenario inclusive of the Delegated Engineering Services required
2. Refer to the Contractor's Specialty Wet Play Structural Engineer, whose duties are described in Division 1.

PART 3 - EXECUTION

3.01 BASIC POOL BASIN CONSTRUCTION & INSTALLATION

A. GENERAL

1. Equipment and materials must be installed per referenced State & Local Building Codes, standards, the manufacturer's instructions & recommendations, and the Contract Documents.
 - a. In the event of a conflict, notify the Architect and This Engineer to request a written clarification.

- b. All basins, self-contained filtration systems, and tanks must be located on the property in compliance/observing all property lines and governmental-utility required setbacks.
 - c. Without exception, each manufacturer's written certifications are required certifying the Contractor provided proper materials, equipment, related hardware, & installations. The Contractor's responsibility includes all costs necessary to attain the manufacturers' certifications.
 - d. All pools must be of such shape and design to be operated and maintained safely and sanitary.
 - e. While the site locations of specified equipment are general, the Contractor must coordinate with other trades to ensure no conflicts.
 - 1) Site coordination with the Architect and the Landscape Architect's Drawings are the responsibility of the Contractor. If there are conflicts, the Contractor must submit a request for clarification from This Engineer as well as the Architect/Landscape Architect.
 - 2) Additional coordinates, if desired, may be obtained from the AutoCAD Drawings available from This Engineer.
2. Unobstructed basin clearances
- a. The pool water must be unobstructed by any structure unless justified by engineering design as part of the recirculation system. No structure, sun shelf, or obstruction must be placed within the basin or 15-feet (4572 mm) perpendicular distance of any pool wall.
 - b. Exception: Water Play Structures in a zero-depth entry area [in depth 3-feet or less [914 mm to 0 mm] may be within 15-feet [4572mm] of the pool walls but must comply with sound engineering requirements to assist in the safety of pool patrons
3. Install components, equipment, materials, infinity edges, and weirs:
- a. Correct and precisely level.
 - 1) Variance exception: The maximum variance from the highest point to the lowest point must not exceed 0.125-inches [3.17 mm].
 - b. This Engineer's design and the manufacturer's published-recommendations are in strict agreement with all applicable codes and regulations, anchoring firmly and securely for long life under hard use.
 - c. Must be braced and anchored to resist a horizontal force acting in any direction using the Drawings criteria.
4. Protect Equipment from damage during installation and through substantial completion. At the Contractor's expense, he must replace blemished & damaged parts, components, and equipment.
5. Before installing this section's items, carefully inspect other trades' Work, and verify that such Work is complete before this installation can properly commence.
- a. Caution: The exactness of grades, elevations, dimensions, or locations given on any Drawings issued by the Architect or This Engineer, or earlier work installed by other contractors, is not guaranteed by the Architect, This Engineer, or the Owner, and require field-verification by the Contractor.

- b. The Contractor must use his commercially reasonable efforts to verify the accuracy of all grades, elevations, dimensions, locations, and faulty work before proceeding with his work.
 - c. The Contractor must rectify, without any additional costs to the Architect, This Engineer, or the Owner, any errors associated, relating, or resulting from his failure to promptly report in writing to the Architect, This Engineer, and the Owner. Such errors include improper-installations & inaccuracies by other trades, which are discovered by the Contractor, after the exercise of commercially reasonable care, as they relate to grades, elevations, locations, or dimensions to the extent that the failure to report such inaccuracy caused such additional costs and could have been discovered by Contractor after the exercise of commercially reasonable efforts.
 - 1) For such events/occurrences, the Contractor is financially responsible for reworking, providing alterations, corrections, remediation efforts, related tasks, equipment damage, replacement of materials (including required labor & supervision), and additional costs for subsequent Engineering time and observations.
- 6. Verify that swimming pool mechanical equipment can be installed per the original design and all referenced standards.
 - 7. Stainless-steel equipment must be installed no more than 30-days before filling the basins to protect the stainless-steel components and their visual appearance.
 - 8. The Contractor's responsibility is to protect the stainless-steel equipment's finishes and deliver an appearance to be like-new without exceptions.
 - 9. Environmental Requirements for manufactured products & Single Layer EVA-rubber copolymer tile wet area surfacing system:
 - a. Install the surfacing system when the minimum ambient temperature is 40 degrees F [1-degree C], and the maximum ambient temperature is 90 degrees F [32 degrees C].
 - b. Do not install in rain
 - 10. Discrepancies:
 - a. In the event of a discrepancy, immediately notify This Engineer.
 - b. Do not proceed with this installation in areas of the discrepancy until all such discrepancies have been fully resolved and approved by The Engineer.
 - c. Failure to notify this Engineer and give written notice of discrepancies must constitute acceptance by the Contractor of existing conditions as fit and proper to receive the Work.
 - 1) For such events/occurrences, the Contractor is financially responsible for the re-working & alterations, including corrections & remediation efforts & related tasks, equipment damage, replacement of materials, required labor & supervision, and additional costs for subsequent Engineering time and observations.
- B. EARTHWORK & SITE EXAMINATION**
- 1. Protect adjacent and nearby existing work, structures, landscapes, and finishes.
 - 2. Verify the following:

- a. Existing conditions - a site examination by a knowledgeable Contractor's representative is mandatory to be followed by a contractor-generated report within the shop-drawings explaining the existing conditions that must be impacted by construction & implementation of the Contract Documents.
 - 1) Without exception, the Contractor must comply with the Geotechnical Consultant's recommendations, as indicated in the latest soils report.
 - b. Substrate conditions conform to the Contract Documents.
 - c. Conditions (including elevations, dimensions, & layout) comply with the Contract Documents.
 - 1) Compliance with this prerequisite must be satisfied by the Contractor providing a site examination before executing the agreement for the construction
3. Formwork
- a. Provide necessary forms as required for described, specified basins & tanks, related construction, and assemblies.
 - 1) These are Complete Build Activities. Refer to the COMPLETE BUILD SCENARIO OVERVIEW
 - b. Prepare forms using commercially-manufactured formwork release-agents that prevent formwork absorption of moisture, prevent bond with concrete, and not stain the concrete surfaces before installing concrete/shotcrete.
 - c. Verify fabricated forms meet the following:
 - 1) True to line and dimension. Verify that finished dimensions are accounted for in constructing the forms. The Contractor's experience, means, & methods must guide and set the dimensional allowances necessary for the Landscape Architect and This Engineer's selected finishes while observing all manufacturers' requirements.
 - 2) Sufficiently robust, secured, and adequately braced against vibration or movement during concrete/shotcrete placement. The formwork must be adequate and sufficient to prevent deflections nor to dislodge.
 - 3) Forms must be constructed to permit the escape of trapped air during concrete/shotcrete placement.
 - 4) Forms must be built/designed to minimize rebound during placement operations.
 - d. Form Ties:
 - 1) Form ties, or through-wall ties of any kind, must not be used when walls are 10-feet [3.05 M] or less. Instead, the formwork must be designed to span vertically from the top of the wall to the bottom of the wall and utilize only external bracing.
 - 2) For walls that are greater than 10-feet [3.05 M] in height, form ties must be acceptable if conforming to the following:
 - a) Constructed so that the form tie, along with an integral water barrier at or near the midpoint of the form tie, remains embedded in the wall, except for a removable portion at each end.

- b) Form ties must have conical type inserts creating cone-shaped depressions at the concrete surface of at least 1-inch [25 mm] in diameter and 1-1/2-inches [37 mm] deep to allow for filling and patching. Inserts must be fixed to remain in contact with forming material and must be constructed so that no metal or rebar ties are within 1.5-inches [37 mm] of the concrete's surface when the forms, inserts, and tie ends are removed. Additionally, the form ties' portions (that remain in place) must have an integral water barrier near the form tie's midpoint.
 - c) Form ties consisting of through-wall tapered bolts entirely removed from the structure are not permitted and must not be used.
 - d) Plug all ties' hole depressions with Portland cement patching mortar product explicitly intended for plugging holes in water retaining structures. Mortar must be of a similar color to the structure and must be installed in strict conformance with its installation directions. Submit manufacturer's product data for review.
 - e) Ties must withstand pressures and limit the deflection of forms to acceptable limits.
4. Earthwork & excavation (for in-ground projects)
- a. Verify that the following have been completed and are compliant with these Specifications:
 - 1) Compacted soils have been pretested to be at a 95% minimum density (using the modified, optimum Proctor test) via the geotechnical consultant's soil reports.
 - a) Refer to the TESTING SERVICES section.
 - 2) Excavation surfaces are clean, smooth, and without voids or irregularities.
 - 3) Evaluation of groundwater table elevation characteristics for use in determining requirements for basin or deck structures and support
 - 4) Ensuring the suitability of soil-bearing capacity for stable and adequate support of structures and equipment.
 - b. The Contractor must provide layout and excavation activities for in-ground projects to include:
 - 1) Perform hand trimming of the excavation as needed to comply with the dimensional requirements.
 - 2) Remove excavated and relocated soils from the job site or relocate to other areas on the location as directed by the Architect or This Engineer. There must be no additional costs to the Owner for soils relocated or removed from the site.
 - a) Over-excavation with removing inferior/substandard soils below the pool basin, pipe trenches, and collector/surge/reservoir tank location as directed within the most recent Geotechnical Consultant's report. Replace over-excavated soils with mandatory engineered backfill monitored by the Geotechnical Consultant.
 - b) Refer to the TESTING SERVICES section.
 - 3) Remove foreign debris and spoils from the site and dispose of them legally per existing regulatory requirements.

- 4) Collector/reservoir/surge tanks require excavation that is approximately 6-feet [1.83 m] larger (on each side) and 2-feet [0.61 m] deeper to allow for engineered backfill and placement of concrete mass ballast anchors.
- c. Excavation areas, including pipe trenches, must be returned to the original grade, compacted to 95% of the optimum modified Proctor test, and surface condition unless otherwise directed in writing by the Architect or This Engineer.
 - 1) Refer to the TESTING SERVICES section.
- 5. Backfill & compaction:
 - a. Compact soil/earth beneath each basin, deck, deck shower, footer, post, and tank to 95% minimum of the optimum modified Proctor test. No deflections or settlement of the soils are permissible. Vacate standing water before placing concrete.
 - b. Certification of the compaction/density testing by a locally-licensed Geotechnical Consulting Engineer is mandatory before providing reinforcing steelwork or other construction installations.
 - 1) Refer to the TESTING SERVICES section.
 - 2) Coordination and compliance with the Geotechnical Consultant's instructions & recommendations are mandatory.
 - 3) Should the basin or deck structures require re-excavations to repair faulty or broken pipes, the Contractor must secure a professional recommendation from the Project's Geo-Technical Consultant to achieve the compaction methods, successful & certified compaction testing.
 - a) Commonly, a lean concrete mix is required to fill voids below the basins or decks.
 - b) The Contractor must bear the expenses and responsibility for all such restorative requirements & re-work without exception, and at no cost to the Owner.
 - c. Collector/reservoir/surge tanks/deck showers/cleaning equipment posts/emergency stop posts/receptacle posts and similar equipment must be installed per the manufacturer's instructions/recommendations, and requirements, including partial water-filling, the quality and type of backfill materials, and compaction efforts.
 - d. Gravel and crushed rock (well-drained backfill) is a mandatory requirement and must be placed around the basin(s) and tank(s) per the requirements of the Drawings and the Technical Specifications.
 - 1) If a tank is pre-fabricated, the Contractor must also adhere to the additional tank Manufacturer's instructions
 - e. For reinforced concrete basins or tanks, do not backfill via mechanical methods before the basin's or tank's structural concrete has gained sufficient strength to withstand the applied load.
 - f. For non-concrete basins and tanks: Backfill using #57 crushed stone placed in 1-ft [305 mm] deep lifts. The Contractor must follow the Contract Documents and the Manufacturer's instructions for additional procedures. The Contractor must implement the following minimum requirements.
 - 1) Refer to CERTIFICATIONS.

- 2) After each lift of backfill crushed stone placement, the tank must be filled with an equal water height.
 - 3) Furnish the specified geotextile materials to help prevent earth (or another authorized backfill material) from encountering the crushed stone materials' layer.
 - 4) The Contractor must comply with the tank Manufacturer's installation and backfill/compaction requirements without exception.
- g. Piping trenches' initial backfill must specifically allow fittings to be accessible for viewing until initial water-pressure tests, regulatory inspection(s), and engineering observations are completed then verified by this Engineer.

C. VAPOR BARRIERS

1. Comply with the requirements of the vapor barrier manufacturer
2. Provide a vapor barrier to prevent the basin & tank concrete/shotcrete structure from encountering the surrounding soils.
 - a. Exception: If Steel-Tex is placed on the walls and the beam, the (wall) vapor barrier may be omitted from those specific areas.
3. Overlap each vapor barrier partial piece a minimum of 6-inches [150 mm].
4. Provide 12-inches [305 mm] long tape fasteners (or its equivalent) on 36-inches [914 mm] centers at overlap junctures.
5. Seal the vapor barrier at each piping penetration.
6. Verify that hydrostatic relief locations are unobstructed by the vapor barrier.

D. DRAINAGE MAT

1. Provide a sloped surface of 2% minimum via the use of a compatible cementitious mortar
 - a. The thickset mortar must be compatible with the Architect's waterproofing.
 - b. The substrate beneath the mortar must pre-approved in writing by the thick-set mortar manufacturer.
 - c. Allow the mortar to achieve curing hardness and compressive strength before proceeding
2. Comply with the requirements of the drainage mat manufacturer
3. Clean surface of loose-debris and install Sika® Drainage Mat directly on Sikalastic® RoofPro and Sikalastic®-320 – NS/SL membrane with the filter fabric side up and membrane protection layer down and in the direction of maximum slope. Observe all manufacturer-instructions.
 - a. For other waterproof materials – the contractor must verify compatibility for adhesives and related materials
4. Attach the mat to the membrane surface with Sikaflex® 11FC or approved adhesive as necessary to keep the mat in position. At edge overlaps, place adjacent panels, so the cores abut and secure the fabric at 3-feet to 5-feet [0.9 M to 1.5M] intervals with Sikaflex® 11FC or approved adhesive.

5. At roll-ends and abutments without overlaps, peel back fabric and remove 4" (10.2 cm) of the core, then secure overlap. All core joints and terminations must be covered by fabric overlay.
6. Direct all drainage mats to empty/drain water to the Architect's nuisance drains located at the Architect's vault/tank's deepest location.
7. Drainage mat installation must comply with the manufacturer's requirements before proceeding.
 - a. Contractor to provide a written acceptance from the manufacturer's or their representative.

E. DEWATERING

1. Perform dewatering of excavated and surrounding areas as required. Such dewatering responsibilities must comply with the recommendations of and directed within the most recent Geotechnical Consultant's report. The Geotechnical Consultant mentions of seasonally-high water tables (or similar) must be interpreted as factual and incorporated into the Contractor's dewatering responsibilities.
 - a. Refer to the TESTING SERVICES section.
2. Dewatering efforts include, but not be limited to, the pool basin structure areas, pipe trench locations, and collector/reservoir/surge tanks' locations.
3. The pool basin structures are not designed to withstand hydrostatic uplift or groundwater conditions that could cause the basin structure's floating. The hydrostatic relief device and pool plugs specified must be provided to assist in this area of concern.
 - a. Order the pool plug (hydrostatic relief device) with no plaster installed to finish with the same interior finish as specified herein. An identical color match is required.
 - b. Provide 1 cu feet [28 L] of 0.75-inch [20 mm] non-porous crushed stone beneath each hydrostatic relief plug cone & dewatering valve box and at the base of other specified equipment as noted.
 - 1) At each drain sump, collector tubes must be provided with crushed stone surrounding the thickness's tube, as indicated in the Drawings.
 - c. Puncture / remove the vapor barrier at each hydrostatic relief cone, hydrostatic collector tube, drain sump, underwater light niche, and pool plug location.
 - d. However, multiple de-watering outlets/locations around the Pool and at all tank locations are a Contractor's responsibility.
4. Crushed stone to assist in dewatering control:
 - a. Crushed stone layer thickness must be increased as needed depending on what layer thickness is necessary to accommodate and control the groundwater encountered, for other structural considerations, to minimize standing water presence.
5. Dewatering systems:
 - a. At a minimum, provide a deadline-type dewatering pipe (minimum 2-inches [50 mm] Type 2 (Sch 80 PVC) piping extending from the specified crushed rock/stone bed (below the drain assembly sump) to the surface elevation (for future accessibility and) to assist in allowing removal of the groundwater from beneath and around the basin.

- b. Provide a minimum of two such dewatering device assemblies beneath each basin. A minimum of 18-inches [455 mm] of the specified crushed stone bed must surround each dewatering pipe terminus.
- c. Provide a valve box enclosure visible at the ground surface end of the deadline dewatering pipe(s) to assist the operator in locating these pipes in the future. Record the dewatering pipe terminus locations on the Record-Set drawing.
 - 1) Do not permanently affix the cap on top of the deadline dewatering pipe.
- d. The Contractor's dewatering systems must be in place and operable on below-grade installations when there is a groundwater presence. No visible water must be evident.
- e. Vertical test pipe for water level detection
 - 1) Provide:
 - a) 8-inch [200mm] diameter perforated pipe such as ADS N-12® ST IB PIPE (or equivalent to) encased in a filter sock from the manufacturer.
 - b) Locate/place the ADS pipe vertically on a reinforced concrete pad with dimensions no less than 32" x 32" x 6" with 3,000 PSI concrete and reinforced with #4, grade 60 spaced at 8" o.c..e.w. – or an equivalent pre-fabricated reinforced concrete equipment pad.
 - c) Vertical-perforated pipe on the concrete pad and surround/encase the vertical ADS pipe with 1 minimum of 12-in of 0.75" crushed stone held in place to prevent soil contact with a geotextile filter fabric
 - d) 18" x 18" NDS cover and grate to terminate 6" above the surrounding earth.
 - e) Cap over the 8" pipe to allow easy removal to determine the elevation of groundwater

F. STEEL REINFORCEMENT & STRUCTURE

- 1. Unless otherwise drawn, the following installation of rebar must be followed:
 - a. The horizontal-located rebars must be positioned on chairs or concrete shotcrete blocks to confirm a minimum 3-inches [75 mm] concrete cover.
 - b. The vertically-located rebars must be accurately and securely positioned to certify a critical 3-inches [75 mm] concrete cover.
 - c. When single mats of rebars are installed, they must be placed in the concrete placement center with the minimum coverage denoted in the Drawings.
- 2. Place and fabricate reinforcement per ACI 506.2 for shotcrete and ACI 318 for cast-in-place concrete.
 - a. The minimum lap splice/overlap of reinforcing bars must be 48 bar diameters unless noted otherwise.
 - b. Hooked rebar must be bent to provide:
 - 1) 12 bar diameters straight extension for 90-degree hooks
 - 2) 24 bar diameters straight extension for 45-degree hooks.
- 3. Unless otherwise stated in the Drawings, the following steel reinforcing and concrete/shotcrete thickness schedule must apply:
- 4.

Location / Purpose	Deformed Rebar Size	Rebar Grade ksi [MPa]	Rebar Spacing O.C.E.W.	Concrete/shotcrete Thickness
Pool Basin(s)	#4	60 [420]	12-inches [305 mm]	8-inches [200 mm]
Pool Beams with < 2.5-inches [62.5 mm] of concrete cover	#2	60 [420]	6-inches [150 mm]	Refer to Drawings
Inside corners (re-entrant angles) in basin requires diagonal rebar placement	#4	60 [420]	5 bars – place first bar 3-inches [75 mm] clear from corner to the rest at 6-inches [150 mm] O.C. and each bar being 8-feet [2.43 m] in length	
Below-Grade Tanks and Vaults (Double Mat)	#6	60 [420]	10-inches [250 mm] - top and bottom mats of steel required in floor & ceiling and double mats in walls (each mat being located 3-inches [75 mm] clear from the face of concrete surfaces)	12-inches [305 mm]
Pipe Penetrations Additional Rebars	#5	60 [420]	When pipes or link seals penetrate a wall, ceiling, or floor within a basin, vault, or tank, place additional, extra rebars in the immediate vicinity as indicated in the Drawings and A.10 of this specification section	12-inches [305 mm]
IWF Slab-on-grade	#5	60 [420]	8-inches [200 mm]	8-inches [305 mm]

Housekeeping Pads	#4	60 [420]	12-inches [305 mm]	Refer to Drawings
Below-Grade Mass Inertia Anchors	#4	60 [420]	12-inches [305 mm] in horizontal layers not further than 12-inch apart	Refer to Drawings
Pool Basin Floors (when Pilings / Piers provide the basin support)	#5	60 [420]	10-inches [250 mm] – top and bottom mats of steel required	12-inches [305 mm]

5. In the event of questions, contact This Engineer for clarification.
6. Bars that have been cut or spliced must be coated with a bonding primer and a reinforcing corrosion protection coating with Sika Armathec 1C, provide/install as directed by the manufacturer.
7. Place reinforcement per ACI 506.2.
8. If pilings are required, additional rebars (in varying grades & schedules) must be necessary, as noted in the Drawings. Piling / Pier contact with the basin floor must be via specially ADE-designed piling caps as indicated in the Contract Documents.
9. Install special reinforcing as shown in the Drawings and as required by this Section.
10. Install the rebars' grounding and bonding system as required by the NEC, the Drawings, these technical specifications, and the Contract Documents.
11. Tie splices with an 18-gauge annealed wire as specified in the referenced CRSI standard.
 - a. Tie wires must be "made tight" for electrical bonding purposes, as required by NEC, Article 680.
 - b. Place steel tie wires tight at each rebar intersection and a minimum of 3 tie wires tight at rebar overlaps (equally spaced)
12. When penetrations (piping or link-seal sleeves) penetrate walls, floors, and ceilings, extra rebars are placed in the immediate vicinity, as indicated in the Drawings. These additional rebars are to be placed as shown in the Drawings and as noted below (in the event the Drawings and this specification conflict, the more stringent must apply):
 - a. (2) #4 bars horizontal and vertical at penetration quadrants
 - b. (2) #4 bars in a diagonal placement (forming an "X" appearance)
 - c. The minimum length of these extra rebars must be 4-feet [1.22 m] + "X" (with "X" being the penetration diameter)
 - d. A minimum of 3-inches [75 mm] of concrete cover is required
13. Reinforcing steel with active-corrosion requires a sandblasting on the steel to return it to a white metal finish removing contaminants and rust.
14. Where corrosion is suspected of occurring due to the presence of chlorides, high-pressure wash after mechanical cleaning. Prime steel with two coats of Sika Armathec 110 EpoCem as directed by the manufacturer. (See Sika's Spec Component SC-201-0699); www.usa.sika.com

G. JOINTS EXECUTION

1. Refer to the TCNA (Tile Council of North America) for movement joints, ACI (American Concrete Institute), applicable codes and standards, manufacturers, and the Contract Documents for minimum standards for joint placement and separations.
 2. Provide cut joints, expansion joints, and movement joints per the Contract Documents and must include, but not be limited to, the following locations:
 - a. Tiles & natural stone on beams, floors, and walls
 - b. Coping, natural-stone fields, and interior finishes
 3. Provide isolation joints as per the Documents without exception
 4. Follow & observe the manufacturer's recommendations & requirements without exception.
 - a. Provide 2 rows of 1-inch x 1-inch [25 mm x 25 mm] of slip-resistant tiles (in white color) on each side of the underwater, submerged, expansion-joint materials (joint trench) continuous on perimeter beam, floors, & walls.
 - b. Use of manufacturer-required primers are mandatory
 - 1) Caution: Observe curing times for all products.
 - 2) An Engineering observation is necessary before proceeding – refer to Section 1.09.F.
 5. Natural stone joints:
 - a. Test a small area with the joint sealant to guarantee success (allow 24-hours) to observe potential fluid migration and verify results.
 - b. Finish joints with a "jointing tool" before completion for a professional finish. Proper tooling of the sealant assures contact with the joint flanks.
 6. Utilize closed-cell backer rods or bond breaker tape to control the depth of joint sealants and related materials.
 7. Observe all manufacturer-required curing times and temperature limitations when installing jointing-materials.
- H. POLYPROPYLENE EXPANSION BOARDS, BACKER RODS, & BOND-BREAKER TAPE
1. Install in strict adherence to the manufacturers' recommendations.
 2. Install pre-approved polyethylene-based, closed-cell backer rod or bond breaker tape in joints subject to thermal movement to prevent three-sided bonding and set the sealant's depth at a maximum of 0.5 inches [13 mm] when measured at the center point of the joint width.
 - a. The joint width ratio to sealant depth should not exceed 2:1 unless pre-authorized by the sealant's manufacturer.
 3. Before the Contractor ordering, this Engineer must review & approve the closed-cell backer rod, bond breaker tape, or polypropylene expansion boards.
- I. EXPANSION JOINT FILLER EXECUTION
1. Adhere to the manufacturers' instructions and requirements without exception.
 2. Position against initial pour placement but before the adjacent concrete placement commences.
 3. Recess the Expansion Joint Filler sufficiently below the concrete surface to allow necessary dimension/space for the Emseal or other ADE-approved expansion joint.

J. ADMIXES & CEMENTITIOUS WATERPROOFING EXECUTION

1. The Contractor must provide a water-tight, leak-proof structure.
2. Minimum waterproofing procedures:
 - a. Fill around each fitting & niche with a non-shrink, expansive grout.
 - b. Avoid honeycombing. Any honeycombing discovered must be chipped, cleaned, and corrected as directed by The Architect and This Engineer.
 - c. Minor surface cracks or shrinkage cracks must be chip-expanded, cleaned, and filled per the Drawing details and these specifications.
 - 1) Fill with Sikadur Duoflex NS per manufacturer's instructions; www.usa.sika.com
3. Gunitite ("shotcrete dry-mix") is disallowed.
4. Provide the shotcrete wet mix as specified herein. Note that underground vaults, backwash-sumps, balance tanks, collector tanks, reservoir tanks, and surge tanks must be poured-in-place or pre-cast cementitious structures (unless an alternate direction is provided in the Drawings). Such installations must achieve a high-quality density, consolidated structure via the use of vibratory tools.
5. Provide a thickened, reinforced basin shell behind underwater light niches and inset steps placed in the basin wall.
 - a. Thicken the reinforced basin structural wall at each floor and wall sump, inset step, and underwater light location area as indicated in the drawings.
6. Basins, vaults, tanks, trench structures specified herein must include the waterproof admixes specified herein.
 - a. Exception: For concrete-trenches & tanks only:
 - 1) Apply Xypex Concentrate or BaseCrete (two coats) on the interior surfaces of underground reservoirs and tanks.
7. Cementitious Waterproofing System Coatings:
 - a. General:
 - 1) A BaseCrete Representative must attend the initial application.
 - 2) A minimum of 2 coats is required – refer to the manufacturer's instructions.
 - 3) Conforming on-structure, above grade, basin structures must provide three coats of BaseCrete installed without exception.
 - b. The surfaces must be clean and absent from anything that would inhibit the bonding capacity of the BaseCrete cementitious, flexible, waterproof bond coat.
 - c. The surfaces must be structurally sound & free of any bond-breaking materials.
 - d. If the concrete was not placed using the specified crystalline admix within the concrete mix design, then provide the initial Primary Pool Shell Waterproofing (BaseCrete +) a penetrating, highly viscous concrete densifier is a required prerequisite to the BaseCrete Bondcoat being applied.
 - 1) Utilizing a low-pressure pump-type sprayer, apply two coats in quick succession removing the excess material immediately.
 - 2) When the specified crystalline admix is placed into the concrete design mix for the basin(s) structure, the BaseCrete + application is unnecessary.
 - e. Cold joints, basin cracks, spalls, voids must be repaired before application.

- 1) Utilize the BaseCrete Mesh to build rounded coves in basin corners on all cold joints.
- 2) Build up with the BaseCrete mix.
- 3) Utilize BaseCrete Mesh to fill in and bridge basin cracks.
- f. Mix and prepare materials in completed compliance with the manufacturer's instructions & recommendations.
 - 1) Do not add water to the mix. Use BaseCrete liquid to change the consistency of the mix.
- g. Do not apply to the frozen substrate or in conditions hotter than 105 degrees F [40.5 degrees C] or colder than 40 degrees F [4.4 degrees C].
- h. Apply to a dampened SSD (Saturated Surface Dry) substrate by roller, brush, trowel, or spray. It is preferred to apply the material and work sufficiently into the surface, filling pits, holes, and voids. Allow drying overnight.
- i. Apply a second coat in the same manner as described above, only perpendicular to the first application.
 - 1) A minimum thickness of 1/8" for each coat is required to create a waterproof condition.
- j. Allow curing overnight before further applications and seven days before water testing on swimming pools.
 - 1) Before proceeding, water testing is mandatory for fountains and pools located on-structure.
8. Concrete containing a Xypex Admix product may develop higher ultimate-strengths than bare concrete.
 - a. Application:
 - 1) General:
 - a) Add Xypex Admix to the concrete mix at the time of batching.
 - b) Blend Xypex Admix throughout the concrete. Care should be taken to verify that a homogeneous mixture is obtained.
 - 2) Concrete Batching & Mixing:
 - a) Coordinate mixing procedures with the batch plant.
 - b) Ready Mix Plant: Mix per manufacturer's instructions.
 - c) Each delivery ticket must specify the amount/dosage of Xypex added
9. Pool/basin floors larger than 3,000 sf [278.7 square m] may use a concrete pump to deliver the ready-mix materials to the applicators/installers. Walls and other vertical placement of the pool structure must be via the described Shotcrete methods.
10. The Contractor must wet-cure by placing the entire pool floor underwater within 24-hours of the concrete placement or maintain the concrete surfaces in a continually dampened status for a continuous 14 days.
 - a. Caution: If temperatures are less than 45° F [7.2° C], obtain prior approval from This Engineer.

K. CEMENTITIOUS MATERIALS & REPAIR MORTARS EXECUTION

1. Follow manufacturer instructions & recommendations without exception.
 2. Specific installation care is required for (but not limited to):
 - a. Surface preparations
 - 1) Remove all deteriorated concrete, dirt, oil, grease, and bond-inhibiting materials.
 - 2) The repair's perimeter must be neatly saw cut 1" deep around the perimeter and then chipped until reaching good sound concrete with no feathering before placing new concrete patch materials.
 - 3) No cutting of the rebars is permissible.
 - 4) Utilize high-pressure water blast or other appropriate means to obtain an aggregate surface.
 - 5) Observe minimum and maximum thicknesses for concrete patch materials.
 - 6) Saturate the surface with clean water & substrate must be saturated surface dry (SSD) with no standing water during application.
 - b. Mixing of the products
 - c. Application & finish of the products, including permissible temperatures during the application process.
 - d. Curing of the products must be per the manufacturers' requirements and recommendations.
- L. LINK-SEALS, WATERSTOPS, & WATERPROOF PENETRATION EXECUTION
1. Waterstop installation
 - a. General
 - 1) Follow manufacturer instructions & recommendations without exception.
 - 2) Maintain continuity of water stops at intersections and transitions.
 - 3) Vibratory consolidation of concrete/shotcrete around each water stop is required without exception.
 - 4) The lapping of the waterstop, the use of adhesives or solvents is disallowed.
 - 5) Protect water stop from moisture, water, dirt, oil, and sunlight during the progress of the Work
 - 6) Prevent water migration by four primary measures:
 - a) Reinforced concrete in and around floor area near joint per the Drawings
 - b) Installation of the PVC water stop specified herein
 - c) Installation of Speed Dowels specified herein
 - d) Installation of a sealant system in the construction/expansion joint (noted below)
 2. Waterstop Fittings Sleeve and Fiberglass Waterstop couplings
 - a. Utilize the supplied hole attachment points to secure the water stop(s) in place and main vertical/horizontal/ perpendicular alignment planes
 - b. The Contractor must cover the fiberglass water stop coupling with a minimum 5-inches [125 mm] concrete cover over large pipe diameters (\geq 6-inches [150 mm]).
 - c. Additional sealing methods via the placement of non-shrink grout at the uppermost concrete / pipe juncture are mandatory. Refer to the Drawings.
 3. PVC Waterstop

- a. Field butt splices must be heat fused welded using a Teflon covered, thermostatically controlled, water stop splicing iron at approximately 380 Deg F.
- b. Center waterstop in joint and secured in position using hog rings or grommets spaced at 12-inches on center along the water stop's length. Wire tie to adjacent reinforcing steel.
- c. Provide field-installed hog rings, or factory-installed punched holes or grommets spaced at 12-inches on center along the water stop's length.
4. Hydrophilic Waterstop
 - a. The Contractor must cut coil ends square (or at the proper angle for mitered corners) to fit splices together without overlaps.
 - b. The Contractor must seal splices using cyanoacrylate adhesive (super glue) and LEAKMASTER.
 - c. The Contractor must seal exposed cells of HYDROTITE with LEAKMASTER.
5. Hydrophilic and PVC Intersections: Seal with LEAKMASTER.
6. Strip-Applied Waterstops
 - a. Apply primer/adhesive (matched to the specific water stop material) to dry concrete surface, 2-inches [50 mm] full continuously along the joint, maintaining a minimum of 2-inches [50 mm] clear concrete-cover to the finished face. Refer to the manufacturer's instructions & recommendations.
 - 1) Primer adhesive must be allowed to "dry to the touch" (typically 30 minutes to several hours; dependent on-site conditions) before applying water stop.
 - b. Continuously adhere to the water stop to the concrete utilizing primer adhesive and maintaining a minimum of 2-inches [50 mm] clear concrete-cover to the finished face.
 - c. Apply waterstop the same day as primer adhesive.
 - d. Waterstop must be butt spliced pressing ends together, ensuring no separation or air pockets
 - e. Remove the release paper from the waterstop immediately before concrete placement.
 - f. Examine water stop for premature swelling, discontinuity, and debris contamination before the concrete pour. Replace the unacceptable water stop(s).
7. Speed Dowel System
 - a. Attach bases to the face of concrete forms using a double-headed nail or self-tapping screw.
 - b. The center of the base must be centered on the forms (or positioned as directed by The Architect and This Engineer).
 - c. Before placing concrete, the Speed Dowel sleeve must be slipped over the base.
 - d. Provide a minimum of 18-inches of concrete from the Speed Dowel system and hand-work concrete around the Speed Dowel System.
 - e. Remove concrete forms with bases still attached. Bases may be reused if they remain in acceptable condition.
 - f. Install slip dowels to the 100% depth of the embedded Speed Dowel sleeve and proceed with the next concrete pour.
 - g. Field Quality Control:

- 1) Do not grease dowels.
- 2) Do not use bent or badly sheared slip dowels. Saw cutting is recommended.
- 3) Do not place concrete directly over the Speed Dowel or Speed Load Systems.
- 4) Place edge forms plumb. Out of plumb forms may result in misaligned dowels.

M. SEALANTS EXECUTION

1. Follow manufacturer instructions & recommendations without exception.
2. Specific installation care is required for (but not limited to):
 - a. Surface preparations
 - 1) Observe minimum and maximum thicknesses and the ratio of the sealant's width in a crack or joint versus the sealant's depth.
 - 2) Certify that the correct primer for the sealant is installed per the manufacturer's requirements.
 - 3) Observe manufacturers' requirements for bond breaker tape or backer rod
 - b. Mixing of the products: Refer to the manufacturer's cut sheets for direction.
 - c. Application & finish of the products
 - d. Curing of the products

N. UNDERWATER SEALANTS EXECUTION

1. General:
 - a. Follow manufacturer instructions & recommendations without exception.
 - b. Specific installation care is required for (but not limited to):
 - 1) Surface preparations
 - a) Observe minimum and maximum thicknesses
 - 2) Mixing of the products
 - 3) Application & finish of the products
 - 4) Curing of the products
 - 5) The manufacturer-noted mandatory use of the installation equipment to achieve excellent results.
 - c. Authorized installers:
 - 1) A manufacturer's certified-installer must install the below-noted products or have an authorized manufacturer's representative on-site during the installation of the below noted underwater sealants.
2. Pre-manufactured Underwater Expansion Joint
 - a. The Contractor must appropriately form and prepare expansion joint openings constructed to the exact dimensions and elevations shown on the manufacturer's standard system drawings or as indicated on the contract drawings. Deviations from these dimensions must not be allowed without the written consent of The Architect and This Engineer.
 - b. The Contractor must clean the joint opening of all contaminants immediately before installing the joint expansion system.
 - c. Repair spalled, irregular, or unsound joint-surfaces using manufacturers' standards to repair the substrates in question.

- d. Remove protruding roughness to confirm joint sides are smooth. Confirm that there is sufficient depth to receive the full depth of the size of the Submerseal being installed. Refer to Manufacturers Installation Guide for detailed systematic instructions.
 - 1) Exception: Without exception, this Engineer must have the last right of acceptance or approval.
 - e. No drilling, screwing, or fasteners are permitted to anchor the sealant system into the substrate.
 - f. Qualified installers must install the joint system only per detailed published installation procedures and job-specific installation instructions from the manufacturer's field technician.
 - g. Clean and Protect the joint system materials
 - 1) Protect the joint system and its components during construction. Subsequent damage to the joint expansion system must be repaired at the Contractor's expense. After the work is complete, clean all exposed surfaces with a suitable cleaner that must not harm or attack the finish.
3. Experience and Qualifications:
- a. An authorized Contractor or pool installer (with the on-site oversight of a manufacturer's representative) must provide Submerseal by Emseal [or Willseal] for underwater expansion joints:
 - 1) Submerseal by EMSEAL Joint Systems, LTD; 25 Bridle Lane; Westborough, MA 01581-2603; 800-526-8365. www.emseal.com.
 - 2) Willseal 250BG by Willseal LLC, 34 Executive Drive, Hudson, NH 03051, 800-274-2813, 800-416-0550 (Fax), www.Willseal.com; email: custserv@Willseal.com
 - b. Deck-O-Seal type underwater expansion joints require written certification of qualification for the selected, manufacturer-certified installer.
 - 1) Critical: Deck-O-Seal type joints may only be utilized when installed by a manufacturer's Certified Joint Installer. This experience and certification requirement applies to:
 - a) Horizontal underwater construction/expansion joints: "Dura-White" Deck-O-Seal #125 by Deck-O-Seal Corporation, Hampshire, IL (800-542-7665); www.deckoseal.com.
 - b) Vertical underwater construction/expansion joints: "Dura-White" Deck-O-Seal Gun Grade by Deck-O-Seal Corporation, Hampshire, IL (800-542-7665); www.deckoseal.com.

O. EXTRUDED POLYSTYRENE (XPS) INSULATION TYPE VI EXECUTION

- 1. Adherence to manufacturer's qualifications and recommendations.
- 2. For horizontal-applications, always turn the print side down so the black print does not show to the sun, which may frequently act as a solar collector, raising the foam's temperature beneath the print to an unacceptable level.

3. Provide a final finish covering or temporary white opaque covering to avoid possible damage when dark (non-white) surfaces are used for insulation. Do not cover insulation either stored (factory wrapped or unwrapped) or partially installed, with dark-colored (non-white) or transparent (non-opaque) coverings, or leave it exposed to the sun.

P. ADHESIVES & GROUTS EXECUTION

1. Without exception, the Contractor must install only epoxy type grout into finishes.
2. Observe the installation & recommendations by adhesive and grout manufacturers.
3. All surfaces must be clean, sound, free of oil, waxes, frost, curing agents, form release agents, or other bond inhibiting contaminants.
4. Prepare, and water blast surfaces
5. Follow ANSI specification A108.01-3.7 "Requirements for Movement Joints: Preparations by Trades" or TCNA detail EJ-171 "Movement Joints – Vertical and Horizontal."
6. Exterior stone installations require the use of "LATASIL" at all joints. Refer to the Landscape Architect for color selections.

Q. PIPING INSULATION & WATER-PROOFING VAPOR BARRIER EXECUTION

1. General:
 - a. All below-grade, insulated piping systems must be a minimum of 18-inches below the finish grade (measured to the top hemisphere of piping)
 - b. Below-grade piping insulation must be wrapped in a waterproof vapor barrier jacketing.

R. EQUIPMENT & PRODUCT INSTALLATION & PROTECTION

1. All Equipment must be installed per the manufacturer's instructions, recommendations, and the Contract Documents.
 - a. In the event of a conflict, notify in writing The Architect and This Engineer requesting a written clarification.
2. The Contractor must employ/institute all necessary procedures and provide related protective materials to care for and protect all equipment & products.
3. Before the Substantial Completion event and the Owner's acceptance, all equipment must be new and in pristine condition.

3.02 SHOTCRETE WET-MIX EXECUTION

A. GENERAL

1. All formwork and alignment wires must be arranged to result in the execution of achieving a level beam placement. The uppermost portions of the structural basin beam (and weir structures) are level without exception. The basin structure must terminate above the designed water-line to provide a water-proof structure.

B. PREWORK VERIFICATIONS

1. The following applies to shotcrete and ready-mix concrete installations.
2. Before beginning any shotcrete wet-mix, confirm the Site meets the following:
 - a. Excavation has been performed as per the Contract Documents.

- b. Excavation surfaces are clean, smooth, and without voids or irregularities.
- c. Soil compaction/density tests have been completed and certified.
- d. Sub-floor piping is in place (with constant pressure-test as noted herein)
- e. Specified governmental piping inspections are successfully attained
- f. Vapor barriers are in place.
- g. Reinforcing steel has been installed per the Contract Documents.
 - 1) Verify sufficient clearances exist to allow specified encasement.
 - 2) Verify that reinforcing steel is adequately positioned and supported.
- h. It contains adequate access to shotcrete wet-mix areas for screeding and finishing and to permit uninterrupted application once the placement operation has begun.
- i. Concrete forms have been installed and oiled per the Contract Documents.
- j. Underwater expansion joints are located, and formwork in place to receive the underwater joints. Expansion joints are required for floors, walls, perimeter beams, and coping.
- k. Pool fittings (drains, inlets, skimmers, gutter fittings, & similar equipment) are placed per the Drawings.
 - 1) Note that drains, niches, & skimmers must be encased entirely with shotcrete wet-mix during the shotcrete installation.

C. ENVIRONMENTAL REQUIREMENTS FOR SHOTCRETE WET-MIX

- 1. Do not begin shotcrete wet-mix application operations unless the following environmental requirements are satisfied:
 - a. Affirm materials and surrounding air temperatures are higher than 45° F [7° C] before, during, and for 7-days after completion of shotcrete wet-mix operations.
 - b. As necessary, during freezing or near-freezing weather, provide equipment and cover to maintain a minimum of 45°F [7°C] and to protect work completed and work in progress.
 - c. Any concrete damaged by freezing must be removed and replaced at no additional cost to the Owner.
- 2. Suspend shotcrete wet-mix operations during high winds, rainy weather, or near-freezing temperatures when work cannot be protected.
- 3. Weather Conditions:
 - a. For shotcrete flatwork being placed in either hot, dry, or windy conditions, monomolecular film (evaporation retardant) is recommended to control bleed water loss.
 - b. Cold-Weather Placement:
 - 1) Comply with provisions of ACI 306 and as follows.
 - a) Protect concrete-work from physical damage or reduced strength caused by frost, freezing actions, or low temperatures.
 - b) When air temperature has fallen to or might be expected to fall below 40-Deg F [4 Deg C], uniformly heat mixing water and aggregates before mixing to obtain a concrete mixture temperature of no less than 50-Degrees F [10-Deg C] and not more than 80-Deg F [27 Deg C] at point of placement.
 - c) Don't use frozen materials or materials containing ice or snow.

- d) Don't place concrete on frozen subgrade or subgrade containing frozen materials.
- e) Don't use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

c. Hot-Weather Placement:

- 1) When hot-weather conditions exist that would impair concrete quality and strength, place concrete complying with ACI 305, ASTM C 94, and specified.
 - a) The contractor must cool/chill ingredients before mixing to maintain the precise temperature at the time of placement to below 95 Deg F [35 Deg C]. Mixing water may be chilled, or chopped-ice may be used to control temperature, provided water equivalent of ice is calculated to the total amount of mixing water. Using liquid nitrogen to cool the concrete is the Contractor's option.
 - b) When the air temperature is between 85 deg F [29 deg C] and 90 deg F [32-deg C], reduce mixing and delivery time from 1.50 hours to 75 minutes, and when the air temperature is above 90 deg F [32 deg C], reduce mixing and delivery time to 60 minutes.
 - c) Cover the reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature must not exceed the ambient air temperature immediately before embedding in concrete.
 - d) The Contractor must fog spray forms, reinforcing steel, and subgrade just before placing concrete and keep subgrade-moisture uniform without puddles or dry areas.
 - e) Use water-reducing & retarding admixtures when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

D. PREPARATION

- 1. Remove obstructions and foreign debris from substrate surfaces.
- 2. Remove square external corners from the substrate by chamfering or applying a radius to the edges.
- 3. Do not place shotcrete wet-mix or ready-mix concrete on frozen, spongy surfaces or where it is free-flowing or standing water.
- 4. Determine operating procedures for placement during close quarters, extended distances, or significant obstructions where placement velocities and mix consistency may be adjusted during application.
- 5. Clean and thoroughly wet cementitious or absorptive substrate surfaces before receiving shotcrete wet-mix. Keep porous surfaces damp for a minimum of 2 hours before the placement of shotcrete wet-mix.

E. ALIGNMENT CONTROL

- 1. Provide alignment wire to establish thickness and plane of specified surfaces.
- 2. Install alignment wire at corners and offsets not set up by forms.
- 3. Tighten the alignment wire sufficiently to prevent movement. Position adjustment devices to permit additional tightening.

F. APPLICATION

1. Direct outlet nozzle perpendicular to the surface to confirm maximum compaction with the minimum rebound.
2. The Contractor must provide/oversee the shotcrete wet-mix's build-up to a specified thickness in multiple nozzle-passes to achieve layering. Encase reinforcement with the first pass.
3. Basin structure(s) or sumps must be developed to a minimum shotcrete wet-mix covering of 3-inches [75 mm] over steel reinforcing as specified on the Drawings.
4. Rebound is aggregate mixed with some cement, which ricochets off the surface during the application of shotcrete due to the collision with the hard surface, reinforcement, or with the aggregate particles themselves, which amounts vary with the position of the work, air pressure, cement content, maximum size and grading of aggregate, & amounts of reinforcing/thickness of the layer.
 - a. Rebound materials must not be reused in any form of shotcrete work and must never be worked into the nozzleman's construction application.
 - b. Remove rebound.
 - c. Discard salvaged rebound.
 - d. Remove trapped rebound at construction and expansion joints.
5. Allow each layer to take the initial set before applying the succeeding layers.
6. Do not permit applied shotcrete wet-mix to sag, slough, or displace.
 - a. Collapsed, displaced, or fallen materials must be removed from the pool basin and not reused.
7. After the finished top layer's initial set, remove excess material outside of forms and alignment lines.
8. Finish surface of the top layer with wood float finish.

G. CURING AND PROTECTION

1. The below-listed procedures are mandatory.
2. Dampened / wet: Total water spraying / immersion / moisture curing / thoroughly dampened status is required.
 - a. Commence initial curing as soon as the free water has disappeared from the concrete surface after placing and finishing.
 - 1) Exception: Allow the initial 8-hours from placement for an initial set to occur.
 - b. Keep shotcrete wet-mix / cast-in-place surfaces thoroughly dampened to assist in the curing process).
 - 1) Only frequent or intermittent wetting is unacceptable.
 - 2) Sprayed-applied curing compounds are disallowed and must not be used.
3. Pre-approved curing methods:
 - a. Concrete wet-cure time of 14-days minimum at 45° F [7.2° C] minimum temperature.
 - b. Use continuous water fog spray or cover the concrete surface with absorptive cover produced explicitly to wet cure concrete, thoroughly saturate cover with water, and keep continuously wet.

- 1) Place absorptive-cover to provide coverage of concrete surfaces and edges, with a 4-inches [100 mm] lap over adjacent absorptive covers.
 - c. The relatively constant temperature to be maintained for hydration of cement and hardening of shotcrete wet-mix / cast-in-place concrete surfaces.
4. Protection:
- a. Protect freshly-placed concrete from premature drying and excessive cold or hot temperatures.
 - b. In hot, dry, windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation control material. Apply per manufacturer's instructions after screeding and bull-floating, but before power floating and troweling.

H. FIELD QUALITY CONTROL

1. Sound-test the applied material with a hammer for hollow-sounding and voids. Expose hollow-sounding and voids then, at the Contractor's expense, replace with new shotcrete wet-mix ensuring 100% bond with contiguous work.
2. Quality Control Testing During Construction: Perform sampling and testing for field quality control during the placement of concrete, as follows:
 - a. Sampling Fresh Concrete: ASTM C172, except to modify for a slump to comply with ASTM C94.
 - b. Slump: ASTM C143, one test for each load at the point of discharge, and one for each set of compressive strength test specimens.
 - c. Concrete Temperature: Test hourly when the air temperature is 40° F. and below and when 80° F. and above; and also, each time a set of compressive test specimens is made.
3. Test panels are required for Shotcrete Dry-Mix:
 - a. Prepare test panels (wire baskets) per ASTM C1140.
 - b. Perform tests on panels per ASTM C1140 and determine acceptability per ACI 506.2.
 - c. If test panels are not available for compressive testing, compressive testing of cores must be performed per ASTM C1604, with the cores' locations being chosen by the structural engineer.
 - d. The Contractor must pay for such additional testing as may be specified when unacceptable concrete is encountered.
4. Provide core samples for inspection and testing for conformance to the design mix.
5. The Contractor must arrange the Architectural & Structural review and corrections required on the concrete basins before installing the finishes.
 - a. Refer to ENGINEERING OBSERVATIONS.
 - b. It is anticipated that minor cracking may develop within the basins during construction. Such cracking is not abnormal and is generally expected. The Contractor is responsible for all costs related to locating, correcting, repairing, and filling each crack - fulfilled with labor and materials - as needed to return the basins' structures to a pristine, waterproof condition.

- c. Before installing the waterproofing and interior finish materials, the Contractor must locate each crack and mark / record it in a scaled drawing/plan for submittal to The Architect and This Engineer.
 - 1) Upon reviewing the recorded cracks, The Architect and This Engineer must guide the Contractor to the recommended treatment, remediation, and corrections/repairs needed to address the cracks.
- d. The recommended repair of the cracks must involve at a minimum:
 - 1) Chipping, trimming, and cutting the crack to be approximately 0.5-inch [12 mm] in width, extending down into the concrete structure 0.5 inch maximum within the cut.
 - 2) The Contractor must provide removal of concrete dust and debris (resulting from the cutting activities).
 - 3) Utilizing the installation procedures from an authorized and recognized concrete crack repair system, the Contractor must carefully re-fill the cracked area to be flush with the adjacent surfaces per the manufacturers' instructions & recommendations. The crack repair system must include primers, filling materials, and crack-repair fabric directed by the crack repair system's manufacturer.
 - 4) The Contractor must observe curing times as required by the selected manufacturer and as directed and authorized by This Engineer.
- 6. Protection of adjacent surfaces:
 - a. The Contractor must take every possible safety measure to protect adjacent concrete surfaces and adjacent equipment from being damaged by overshooting concrete or shotcrete wet-mix.
 - b. Overshot concrete and rebound materials deposited must be removed at the Contractor's expense.
- 7. Mechanical injury-free:
 - a. There must be no mechanical backfill procedures attempted until the 100% design strength of the structure is achieved

3.03 CAST IN PLACE READY-MIX CONCRETE EXECUTION

A. GENERAL

- 1. Refer to the SHOTCRETE WET MIX requirements above.
- 2. For pre-approved concrete curing methods, refer to CURING AND PROTECTION above.

B. CAST-IN-PLACE CONCRETE READY-MIX TRANSPORT AND PLACEMENT

- 1. Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," as specified.
- 2. When the outside air temperature is between 85 deg F [29 deg C] and 90 deg F [32 deg C], the ready-mix supplier and contractor must reduce mixing and delivery time from 1.50 hours to be 75 minutes, and when the air temperature is above 90 deg F [32 deg C], reduce mixing and delivery time to be 60 minutes.
- 3. Water may be added to the site ONLY if the ready-mix supplier has purposely withheld water at the batching plant, AND the amount of withheld water is indicated on the batch ticket.

- a. If these two requirements are met, water may be added in the field up to the amount that was withheld.
 - b. Record the amount of water added remotely (in the field) and added it to the testing report.
4. Place and thoroughly vibrate concrete to achieve consolidation, leaving no voids or honeycombing, not disturbing or displaying the water stop. Do not allow the vibrator to contact the water stop.
 - a. Apply approved vibrator at points spaced not farther apart than the vibrator's effective radius.
 - b. Apply close enough to forms to vibrate the surface efficiently but not damage the form surfaces.
 - c. Vibrate until concrete becomes uniformly plastic.
 - d. The vibrator must penetrate the freshly placed concrete and into the previous layer of fresh concrete below.
5. Protect freshly-placed concrete from premature drying and excessive cold or hot temperatures.
 - a. Refer to 3.02 Environmental Requirements for Shotcrete Wet-Mix
 - b. during hot, dry, & windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation control material. Apply per manufacturer's instructions after screeding and bull-floating, but before power floating and troweling.
 - c. Do not place concrete when the ambient temperature is below 45° F [7.2° C] and falling without special, pre-approved protection.
 - d. Any concrete damaged by freezing must be removed and replaced at no additional cost to the Owner.

3.04 SHOTCRETE DRY-MIX (GUNITE) EXECUTION

A. GENERAL

1. The use of Gunit (shotcrete dry-mix) is disallowed unless there is total compliance with these requirements.

B. PREWORK VERIFICATIONS

1. The following applies to shotcrete dry-mix (Gunit) concrete installations.
2. Before beginning any shotcrete dry-mix, the Contractor must confirm the Site meets the following:
 - a. Excavation has been performed as per the Contract Documents.
 - b. Excavation surfaces are clean, smooth, and without voids or irregularities.
 - c. Soil compaction/density tests have been completed and certified.
 - d. Specified sub-floor piping is in place (with on-going, constant, pressure-test as noted herein)
 - e. Specified governmental piping inspections are successfully attained
 - f. Vapor barriers are in place.
 - g. Reinforcing steel has been installed per the Contract Documents.
 - 1) Verify sufficient clearances exist to allow specified encasement.

2) Verify that reinforcing steel is adequately positioned and supported.

- h. Provides adequate access to shotcrete dry-mix areas for screeding and finishing and to permit uninterrupted application once the placement operation has begun.
 - i. Concrete forms have been installed and oiled per the Contract Documents.
 - j. Provisions for underwater expansion joints for floors, walls, perimeter beam, and coping are installed.
 - k. Pool fittings (drains, inlets, skimmers, gutter fittings, & similar equipment) have been placed per the Drawings.
- 1) Note that drains, niches, & skimmers must be encased entirely with shotcrete dry-mix during the shotcrete installation.

C. ENVIRONMENTAL REQUIREMENTS FOR SHOTCRETE DRY-MIX

1. Do not begin shotcrete dry-mix application operations unless the following environmental requirements are satisfied:
 - a. Affirm materials and surrounding air temperatures are higher than 45° F [7° C] before, during, and 7 days after completing shotcrete dry-mix operations.
 - b. As necessary, during freezing or near-freezing weather, provide equipment and cover to maintain a minimum of 45°F [7°C] and to protect work completed and work in progress.
 - c. Any shotcrete dry-mix damaged by freezing must be removed and replaced at no additional cost to the Owner.
2. Suspend shotcrete dry-mix operations during high winds, rainy weather, or near-freezing temperatures when work cannot be protected.
3. Weather Conditions:
 - a. For concrete/shotcrete flatwork being placed in either hot, dry, or windy conditions, monomolecular film (evaporation retardant) is recommended to control bleed water loss.
 - b. Cold-Weather Placement:
 - 1) Comply with provisions of ACI 306 and as follows.
 - a) Protect shotcrete dry-mix work from physical damage or reduced strength caused by frost, freezing actions, or low temperatures.
 - b) When air-temperature has fallen to or is expected to fall below 40°F [4° C], the Contractor must uniformly pre-heat the water and aggregates before its mixing to obtain a concrete mixture-temperature of no less than 50° F [10° C] and not more than 80° F [27° C] at point of placement.
 - c) Do not use frozen-materials or materials containing ice or snow.
 - d) Do not place concrete on frozen-subgrade or subgrade containing frozen materials.
 - e) Don't use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in the mix designs.
 - f) Water curing is not permitted during freezing temperatures below 40°F [4° C].
 - c. Hot-Weather Placement:

- 1) When hot weather conditions exist that impair concrete quality and strength, the Contractor must place shotcrete dry-mix complying with ACI 305 and as specified.
 - a) The Contractor must cool/chill ingredients before mixing to maintain the concrete temperature at the time of placement to below 95° F [35° C]. Mixing water may be chilled. As an alternate, chopped ice may be used to control temperature, provided water-equivalent of ice, and the total amount of mixing water. Using liquid nitrogen to chill concrete is the Contractor's option.
 - b) Cover the reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature must not exceed the ambient air temperature immediately before embedding in concrete.
 - c) The Contractor must fog spray forms, reinforcing steel, and subgrade just before placing shotcrete dry-mix. Keep subgrade-moisture uniform without puddles or dry-areas.
 - d) Use water-reducing retarding-admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to This Engineer.

D. PREPARATION

1. Remove obstructions and foreign debris from substrate surfaces.
2. Remove square external corners from the substrate by chamfering or forming a radius in the edges.
3. Do not place shotcrete dry-mix on frozen, spongy surfaces or where there is free-flowing or standing water.
4. Determine operating-procedures for placement in close quarters, extended distances, or around significant obstructions where placement velocities and mix consistency may be adjusted during application.
5. Clean and thoroughly wet cementitious or absorptive substrate surfaces before receiving shotcrete dry-mix. Keep porous surfaces damp for a minimum of 2-hours before placement of shotcrete dry-mix.

E. ALIGNMENT CONTROL

1. Provide alignment wire to establish thickness and plane of specified surfaces.
2. Install alignment wire at corners and offsets not set up by forms.
3. Tighten alignment wire exact to the line. Position adjustment devices to permit additional tightening.

F. APPLICATION

1. Direct outlet nozzle perpendicular to the surface to confirm maximum compaction with the minimum rebound.
2. The Contractor must provide/oversee the shotcrete build-up to the specified thickness in multiple nozzle-passes to achieve layering. Encase reinforcement with the first pass.
3. Basin structure(s) or sumps must be developed to a minimum shotcrete dry-mix covering of 3-inches [75 mm] over steel reinforcing as specified on the Drawings.

4. Rebound is aggregate mixed with some cement, which ricochets off the surface during the application of shotcrete dry-mix because of collision with the hard surface, reinforcement, or with the aggregate particles themselves, which rebound-amount varies with the position of the work, air pressure, cement content, maximum size and grading of aggregate, amount of reinforcing & thickness of the applied layer.
 - a. Rebound-materials may not be reused in any form for shotcrete dry-mix work and must never be worked into the construction by the nozzleman.
 - b. Remove all rebound that does not fall clear of work.
 - c. Discard salvaged rebound.
 - d. Remove trapped rebound at construction and expansion joints.
5. Allow each layer to take the initial set before applying the succeeding layers.
6. Do not permit applied shotcrete dry-mix to sag, slough, or displace.
 - a. Collapsed, displaced, or fallen materials must be removed from the pool basin and not reused.
7. After the finished top layer's initial set, remove excess material outside of forms and alignment lines.
8. The installer must finish surfaces of the top layer with wood float finish.

G. CURING AND PROTECTION

1. The below-listed procedures are mandatory.
2. Dampened / wet: Total water spraying / immersion / moisture curing / thoroughly dampened status is required.
 - a. Commence initial curing as soon as the free water has disappeared from the concrete surface after placing and finishing.
 - b. Keep shotcrete dry-mix / cast-in-place surfaces thoroughly dampened to assist in the curing process).
 - 1) Frequent or intermittent wetting is unacceptable. Wetting must be continuous.
 - 2) Sprayed-applied curing compounds are disallowed and must not be used.
3. Pre-approved curing methods:
 - a. The concrete wet cure time of 7-days minimum at 45° F [7.2° C] minimum temperature.
 - b. Use continuous water fog spray or cover shotcrete dry-mix surface with absorptive cover produced explicitly to moist cure shotcrete dry-mix, thoroughly saturate cover with water, and keep continuously wet.
 - 1) Place absorptive cover to cover shotcrete dry-mix surfaces and edges, with 4-inches [100 mm] of lapping over adjacent absorptive covers.
 - c. The relatively constant temperature to be maintained for hydration of cement and hardening of shotcrete dry-mix surfaces.
4. Protection:
 - a. Protect freshly placed shotcrete dry-mix from premature drying and excessive cold or hot temperatures.

- b. In hot, dry, windy weather, protect shotcrete dry-mix from rapid moisture loss before and during finishing operations with an evaporation control material. Apply per manufacturer's instructions after screeding and bull-floating, but before power floating and troweling.
- c. See the "ENVIRONMENTAL" section for additional protection requirements.

H. FIELD QUALITY CONTROL

1. Sound-test the applied material with a hammer for hollow-sounding and voids. Expose hollow-sounding and voids then, at the Contractor's expense, replace with new shotcrete dry-mix ensuring 100% bond with contiguous work.
2. Quality Control Testing During Construction: Perform sampling and testing for field quality control during the placement of shotcrete dry-mix, as follows:
 - a. Sampling shotcrete dry-mix: ASTM C172, except modified for a slump to comply with ASTM C94.
 - b. Slump: ASTM C143, one test for each shotcrete dry-mix load at the point of discharge, and one for each set of compressive-strength test specimens.
 - c. Shotcrete dry-mix Temperature: Test hourly when the air temperature is 45° F. and below and when 80° F. and above; and each time a set of compressive test specimens is made.
3. Test panels are required for Shotcrete Dry-Mix:
 - a. Prepare test panels (wire baskets) per ASTM C1140.
 - b. Perform tests on panels per ASTM C1140 and determine acceptability per ACI 506.2.
 - c. If test panels are not available for compressive testing, compressive testing of cores must be performed per ASTM C1604, with the cores' locations being chosen by the structural engineer.
 - d. The Contractor must pay for such additional testing as may be specified when unacceptable shotcrete dry-mix is encountered.
4. Provide inspection and testing for conformance to the design mix.
5. The Contractor must arrange the Architectural & Structural review and corrections required on the shotcrete dry-mix basins before installing the finishes.
 - a. It is anticipated that minor cracking may develop within the basins during construction. Such cracking is not abnormal and is generally expected. The Contractor is responsible for the costs related to locating, correcting, repairing, and filling each crack - filled with labor and materials - as needed to return the basins' structures to a pristine, waterproof condition.
 - b. Before installing the waterproofing and interior finish materials, the Contractor must locate each crack and mark / record it in a scaled drawing for submittal to The Architect and This Engineer. Upon reviewing the recorded cracks, The Architect and This Engineer must guide the Contractor to the recommended treatment, remediation, and corrections/repairs needed to address the cracks.
 - c. The recommended repair of the cracks must involve at a minimum:
 - 1) Chipping, trimming, and cutting the crack to be approximately 0.5-inch [12 mm] in width extending down into the shotcrete dry-mix structure 0.5-inch [12 mm] maximum within the cut.

- 2) The Contractor must provide/oversee the removal of shotcrete dry-mix dust and debris (resulting from the cutting activities).
- 3) Utilizing the installation procedures from an authorized and recognized concrete crack repair system, the Contractor must carefully re-fill the cracked area to be flush with the adjacent surfaces per the manufacturers' instructions & recommendations. The crack repair system must include primers, filling materials, and crack-repair fabric directed by the crack repair system's manufacturer.
- 4) The Contractor must observe curing times as required by the selected manufacturer and as directed and authorized by This Engineer.
- d. The finishes' installation installer (hired for and paid by the Contractor) must review each crack repair and validate its condition before commencing with each basin's finishes' installation.
- e. Confirm, verify, and coordinate with the finishes installer that there are no conflicts or physical incompatibility between using the specified waterproofing and the finishes' materials.
6. Protection of adjacent surfaces:
 - a. The Contractor must take every conceivable precaution to protect adjacent shotcrete dry-mix surfaces & adjacent equipment from being damaged by overshooting shotcrete dry-mix.
 - b. Overshot shotcrete dry-mix and rebound materials deposited must be removed at the Contractor's expense.
7. Mechanical injury-free:
 - a. There must be no mechanical backfill procedures attempted until the 100% design strength of the structure is achieved

3.05 NOT USED

3.06 PIPING & ASSOCIATED COMPONENTS EXECUTION

A. PIPING AND VALVING SYSTEMS

1. Install pool piping, as shown in the Drawings per the size schedules in the Drawings.
2. Refer to "PIPING SUPPORT METHODS" for general requirements for piping supports, anchoring, and motion compensation.
3. Install Type 2 or Type 5 piping under and through the pool basin unless otherwise specified.
4. The torque is applied to all bolts per manufacturers' standards and requirements. Install accessories per the manufacturers' instructions & requirements, facility requirements, and these Drawings & Specifications.
5. Double-Walled Piping Containment Systems must be provided per Spears® Double Containment Design & Installation Guide.
6. Each pool must have piping & valving completed to provide the following functions:
 - a. Basin to collector tank (via floor drains, perimeter overflow, or skimmers)
 - b. Collector tank to pump via hair & lint strainers (except for vacuum filter types)
 - c. Pump to waste (before the filter system)
 - d. Pump to the filter system

- e. Vacuum to filter or waste (or a self-contained portable vacuum system)
- f. Filter system to backwash
- g. Filter system to chillers/heaters, UV sterilizers, chemical controller, chemical feeder systems
- h. Filters/chemical/heaters/chillers in equipment room/yard back to the basin
- i. Water level control
- j. Overflow to authorized outfall or pumping to waste authorized outfall depending on the water level within collector/surge/reservoir tanks or basin

B. PIPING LAYOUT & EXECUTION

- 1. Examine piping layouts, locations, and dimensions indicated in the Drawings. Verify that piping locations do not interfere with other equipment or construction before installation.
- 2. As shown in Drawings, piping must be installed to make a complete, comprehensive system.
- 3. Pipes must be installed parallel or perpendicular to the walls or other exposed construction unless a different layout is shown. Cut piping accurately from established dimensions verified at the project site: coordinate piping locations, routing, and minimum clearances from other devices, equipment, & materials.
- 4. Install Clear Pipe, Sch. 80 (Type 7), with a flow meter, in the following locations:
 - a. Flow meters' piping placements:
 - 1) Place a minimum 2-feet [600 mm] length at each flow meter.
 - 2) Center the flow meter at the mid-point of the length of the transparent pipe.
 - 3) The flow indicator rate must be sized appropriately per the design flow rate and measured from 0.5 to at least 1.5 times the design flow rate.
 - 4) Couplings/fittings connecting the specified pipe length must be Clear PVC, Sch 80.
 - 5) Comply with flow meter manufacturers' installation instructions for minimum upstream and downstream straight-run conditions and all manufacturers' instructions & recommendations.
 - a) Exception: Type 7 Clear Piping must not be placed outdoors or where it would be exposed to UV rays.
 - b. Backwash / Waste:
 - 1) Place a minimum 2-feet [600 mm] length on each backwash pipe.
 - 2) Couplings/fittings connecting the specified pipe length must be Clear PVC, Sch 80 (Type 7).
 - a) Exception: Type 7 Clear Piping must not be placed outdoors or where it would be exposed to UV rays.
- 5. Therapy piping systems:
 - a. Therapy or jet pumps must take suction from the collector tank.
 - b. Collector tank sizing by This Engineer has incorporated the additional therapy system's flow-rate and gallonage into the tank's sizing considerations.

C. PIPE CONNECTIONS & SIZING

1. The pipe sizes indicated are required to meet the hydraulic requirements set forth by The Architect and This Engineer.
2. Water Velocity Limitations in Piping:
3. Do not deviate from the pipe sizes shown in The Drawings unless prior written approval is obtained from This Engineer.
 - a. When the size is not indicated, request additional information and This Engineer's decision & judgment.
 - 1) All pressure piping must be sized such that the water flow velocity does not exceed 8-feet per second [2438 mm per second] at the design flow rate unless pre-approved by This Engineer and the governmental agencies. (Exception: Precoat lines when higher velocity may be required for agitation purposes.)
 - 2) All suction piping must be sized such that the water flow velocity does not exceed 6-feet per second [1829 mm per second] at the design flow rate. (Exception: Vacuum filter header assembly when velocities may be up to 10-feet per second [3048 mm per second].)
 - 3) Main (floor & wall) drain systems and surface overflow systems must discharge to collector tanks and are sized such that the water flow velocity does not exceed 3-feet per second [914 mm per second] at the design flow rate.
 - 4) Note: Plastic-type valves and check-valves must not be located on any pipe having a water velocity exceeding 5 FPS unless a written warranty (by the valve manufacturer) is provided to the Owner and pre-approved by This Engineer.
4. If interference with other equipment or the Architect requires relocation of pipes or a layout different from that shown, notify This Engineer for further written instructions.

D. GENERAL PIPING EXECUTION

1. Preparation:
 - a. Before installation, examine piping and fittings for damage or defects. Discard unacceptable units.
 - b. Clean pipe interior of debris, foreign matter, sand, and keep clean during installation. The pipe must not be placed in standing water or when the trench or weather conditions are unsuitable.
 - c. The trench must be excavated to allow 6-in [15 cm] minimum clearance in all directions around the final O.D. of the system.
 - d. The bottom of the piping trenches must be graded to the piping's design slope and to provide uniform bearing along its entire length. Where wet or unstable soils are encountered, such soil must be removed to sufficient depth, and the trench backfilled with coarse sand or loose granular earth. This backfill must be compacted to a density equal to that of the acceptable portions of the trench.
 - e. The rock must be excavated to a 6-in [15 cm] minimum over-depth below the specified trench depth where excavation of rock is required. Over depths in the rock must be backfilled with loose granular earth or coarse sand and thoroughly compacted, including written approval and verification from the testing engineer.
 - f. Keep water out of the trench until the pipe is installed and sealed. While work is in progress, verify the pipe and fittings' open ends are kept closed to prevent trench water, earth, and other foreign matter from entering the piping system.

- g. Caution: A fire or explosion may result if dry granular calcium hypochlorite is used to disinfect plastic piping systems exposed to organic-vapors found in solvent cement, cleaners, or primers water solution is not used.
 - 1) Calcium hypochlorite is a strong oxidizer but common in Pool & Spa chemicals such as "pool shock."
 - h. It is recommended to purify piping runs by pumping nonvolatile chlorinated water into the piping system. Do not store or use dry-granular calcium-hypochlorite near solvent cement, cleaners, or primers.
2. Installation Execution:
- a. The Contractor must provide/observe the subsequent execution, practices, and quality control procedures for the piping installation:
 - 1) Comply with all manufacturer's requirements
 - 2) Cut pipe, "square."
 - 3) Remove pipe burrs (inside and out)
 - 4) Clean pipe ends with a clean rag to remove dirt and moisture
 - 5) Verify that a "dry-fit" is possible and manageable
 - 6) Apply purple primer and cleaner per the manufacturer's requirements
 - 7) Flow solvent weld grey cement on each pipe and fitting with the appropriately sized applicator for the pipe size.
 - 8) The application of solvent weld grey cement is critical due to its rapid setting time
 - 9) Do not "puddle" the grey cement within the fitting or allow the solvent weld cement to "run-down" the interior of the pipe
 - a) Allow 10-seconds open time to lapse before inserting the pipe end into fittings. Refer to the manufacturer's requirements for additional requirements.
 - 10) Assemble immediately by "bottoming" the pipe within the socket and twisting $\frac{1}{4}$ turn while solvent weld cement is still wet
 - 11) Hold & secure the solvent weld cemented joint for a minimum of 60-seconds to help prevent "push out."
 - 12) The installer's workforce must be increased to execute large piping and fittings using mechanical equipment as needed (to follow the manufacturer's requirements).
 - 13) Wipe off / remove excess solvent weld cement but do not disturb the joint for a minimum of 10-minutes – no exceptions.
 - 14) Comply with specified set times scheduled below
 - 15) Place the piping within the trench to prevent damage
 - 16) Snake the pipe within the piping trench (from side to side of the trench)
 - 17) Shade the pipe with backfill; however, leave all joints 100% exposed until successful water-pressure testing has been completed then verified by this Engineer.
 - 18) The curing period must be dependent upon:
 - a) Air temperature and humidity
 - b) Type of and size of pipe
 - c) Type of solvent cement

- d) Dry joint tightness
- 19) Bring pipe to its scheduled operating temperature before backfilling and successful water-pressure testing
- 20) PVC heat welding/bending is prohibited.
 - a) If custom angles on fittings are required, the Contractor must be responsible for providing those custom fittings as may be needed.
- b. Initial Pipe Solvent Weld Cementing Set Times:
 - 1) Comply with the following periods after cementing pipe fittings.
 - a) The installer must double the below times in damp or humid weather.
 - b) Field conditions may lengthen these initial set times.
 - c) For drying times at temperatures that differ from this, consult This Engineer:

PIPE SIZE	AVERAGE INITIAL SETTING TIME	AVERAGE INITIAL SETTING TIME
	Air Temperature: 60° to 100° F [15° to 37° C]	Air Temperature: 40° to 59° F [4° to 15° C]
0.5 – 2-inches [13 – 50 mm]	5 minutes	10 minutes
2.5 – 8-inches [63 – 200 mm]	30 minutes	2 hours
10 – 14-inches [255 – 355 mm]	2 hours	8 hours
16-inches [400 mm] & higher	4 hours	16 hours

- c. Water-pressure testing:
 - 1) Water-pressure testing requires a minimum curing/drying time to be incorporated/observed, allowing the PVC solvent weld cement to cure and take a permanent set. The following table sets forth the minimum drying-period before the mandatory water-pressure tests.
 - a) This chart applies only to weather temperatures ranging from 40° F. to 100° F. Double the noted times when in damp or humid weather. For drying times at temperatures that differ from this table, consult This Engineer:

PIPE SIZE	AVERAGE CURING TIME	AVERAGE CURING TIME
	Air Temperature:	Air Temperature:

	60° to 100° F [15° to 37° C]	40° to 59° F [4° to 15° C]
0.5 – 2-inches [13 – 50 mm]	12 hours	24 hours
2.5 – 8-inches [65 – 200 mm]	24 hours	48 hours
10 – 14-inches [255 – 355 mm]	48 hours	96 hours
16-inches [400 mm] & higher	72 hours	6 days

- d. Conduct hydrostatic water-pressure tests on the gravity flow, pressure, static, and vacuum piping specified in Field Quality Control. If the necessary water pressure is unavailable to achieve the minimum water pressure testing, the Installer must provide a pressure inducing pump with related gauges to achieve the minimum pressure required for the site water pressure testing. Since pool water is present in underwater light conduits, a water-pressure test is also required.
 - 1) Conduct water-pressure testing for PVC materials (Type 1, 2, 3, 4, and 7) at:
 - a) 60 PSI [413.7 kPa] or at 150% of the maximum operating pressure (whichever is greater, for a continuous 24-hours test period with no loss of water and water pressure. If the project's municipal water supply does not provide adequate water-pressure to complete the mandatory testing, then the Contractor must provide, at the Contractor's costs, all necessary equipment portable water pressure supply assembly, including the pressure pump.
 - b) Exception: Main drain assemblies, related gravity flow/open channel flow piping systems, and underwater light conduits must be water-pressure tested for a continuous 24-hours at a minimum of 15 PSI [103.4 kPa] water-pressure test with no loss of water or water pressure.
 - c) Each collector tanks', reservoir tanks,' and surge tanks' water-pressure testing assemblies must be left in place, allowing the water-pressure testing to be continuously maintained until the decking (and other related construction) is completed.
 - d) Caution: Pressure testing via the use of compressed air is prohibited. Winterizing a piping system must not include or involve compressed air being used within the piping system.
 - e. Equipment room located pipe sizes of 3-inches [75 mm] and greater must have flanged connections unless otherwise specified.
 - f. Pipe sizes less than 3-inches [75 mm] may have NPT threaded connections unless flanged connections are necessary to adapt to other devices (valves and similar equipment).

E. PIPING INSTALLATION REQUIREMENTS

1. The piping diagrams, placements, and layouts shown in the Drawings must be followed without exception unless this Engineer's written authorization is issued.
 - a. Exception: Piping is indicated and shown in a diagrammatic view only. Such a depiction allows execution/installation with the Installer's reasonable discretion to meet the site conditions. The determination of the quantity of piping/fittings necessary are solely the responsibility of the Contractor.
 - b. Caution: The number of fittings required is more significant than are graphically indicated in the piping diagrams and equipment room layouts
2. Place pool perimeter piping as close to the pool beam as possible.
3. Place piping below-grade as detailed in the Drawings and as noted below (refer questions to This Engineer):
 - a. Backfill cover depth: Minimum 18-inches [455 mm] between the pipe(s) upper hemisphere and the top of the soil.
4. Piping located beneath and passing through the basin structures must be Type 2 or better, and piping and fittings within the mechanical equipment space must be Type 2 or better.
5. Piping passing through more than one adjacent layer of concrete must be Type 5.
6. Piping in parallel or crossing must have 4-inches [100 mm] minimum clearances to other piping.
7. Type 1, Type 2, Type 3, and Type 4 piping passing beneath buildings, footings, roadways, and any piping subject to other structural load forces must be installed in metallic, steel, HDPE, or Type 9 pipe sleeves rated at a minimum of 175 percent of the designed crush loads. The sleeve must extend a minimum of 12-in [305 mm] beyond the limits of the footer.
8. Climatic/temperature conditions govern the designated pressure-rating capability of the piping systems. Refer written inquiries to This Engineer for clarification.
9. Provide piping, fittings, reducers, braces, hangers, supports, isolation-joints, and expansion-equipment specified for the complete, functional installation.
10. Excavation and backfill procedures must comply with:
 - a. State applicable trench and safety legislation
 - b. OSHA standards for trenches and excavation
11. The Contractor must place piping on a compacted, engineered-soils base that has been verified and tested to be a minimum of 95% of the optimum, modified Proctor test.
 - a. Exception: If the required backfill and compaction cannot be attained, then piping must be strapped to and supported by the basin with the following maximum horizontal spacing:

Pipe Size [inch]:	1	1.5	2	2.5	3	4	6	8+
Max Spacing [feet]:	4	4	4	6	6	6	8	8
Pipe Size [mm]:	25	40	50	65	80	100	150	200+
Max Spacing [m]:	1.2	1.2	1.2	1.8	1.8	1.8	1.8	2.4

- b. Exception: On-structure basins must be installed with piping supported and attached to the pool basin structure per the above chart noting the maximum distance between supports.
12. Backfill & compaction of soils above piping, and operation of heavy equipment near piping:
- a. Backfilling around piping systems must not be allowed until the required water-pressure tests are completed with no loss of water nor water-pressure.
 - 1) Critical Note: The water-pressure tests must be left intact in all piping systems.
 - a) All water-pressure tests must be monitored continuously as a primary method to detect potential underground piping damage during construction.
 - b. Backfill materials: Utilize only engineered fill for piping trenches and excavations. No organic material, clay, or topsoil is permitted or allowed within backfill materials.
 - c. The Contractor's compaction must be verified and tested to be a minimum of 95% of the optimum, modified Proctor test without exception.
 - d. Do not operate heavy machinery or equipment around or above below-grade piping.
 - 1) The Contractor must monitor the continuous water-pressure test specifically while heavy equipment is near any below-grade piping.
 - 2) Piping damage is the Contractor's total responsibility, and immediate repairs are mandatory, including new, verified water-pressure testing event(s).
13. Pipe slopes:
- a. General:
 - 1) At no point must the piping change slopes to allow an air pocket, trap, or dip to occur; hence, high elevations/spots in the piping are prohibited.
 - a) Concentric reducers are expressly disallowed on gravity flow piping, direct suction piping, and static piping.
 - b) All eccentric reducers must be installed with the "flat side up."
 - 2) Piping must be placed on an appropriate grade around the basin, so it must drain entirely by gravity. In instances where gravity drainage is not provided, the Contractor must provide drain valves and sump assemblies so that piping can be drained completely.
 - 3) Provide specialized blow-out plugs, niches, drainable junction boxes, drainable conduits, nozzles, and such drain pipes with valves into the gravity sump (equipped with a sump pump for automatic draining).
 - b. Pipe Slopes' Table:

Pipe Description	Source / Destination	Continuous, Minimum Pipe Slope (more when directed)	Remarks
Gutter	Basin to Surge (or Collector) Tank	2%	Gravity / open channel flow

Basin Floor Drain	Basin to Surge (or Collector) Tank	2%	only eccentric reducers (flat side up) are allowed on the piping
Wet-Deck Drains	Deck to Reservoir Tank	2%	
Therapy Air Supply	Air vent to therapy nozzles	2%	Insect screen w/ minimum 65% open area required
Static (for the auto-fill sensor)	Basin to equipment area	2%	Per fill system manufacturer's requirements; only eccentric reducers (flat side up) are allowed on the static piping

- c. Remove air from the piping system, especially when filling the piping for water-pressure tests.
 - 1) Remove air via valves; incorporate stops at the high points of the line or other pre-approved methods.
 - 2) Caution: entrapped air may create unacceptable surge pressures (water hammer) in the piping system, causing a piping failure.
14. Only Type 5 piping may be installed into air plenums.
 - a. The Contractor must bond, earth, & ground metallic piping at 20-feet [6.10 m] intervals on center. Utilize only UL-listed bond/ground lugs.
 - b. Insulate plenum-located metallic piping and related system components with pre-approved closed-cell pipe insulation.
15. Install a 1-inch [25 mm] Type 1 pipe or better, cold water supply pipe from the ALU anchor deck box to the equipment room's potable water supply.
16. Bolt flanges together per recognized standard practice.
17. Valve and check valve Installations
 - a. Locate check valves a minimum of 10 pipe diameters downstream of any pump or other sources of turbulence.
 - b. The maximum water velocity allowed through plastic-type valves (or check valves) must be 5.0 fps [1.524 mps]. Valves located in locations or positions with water velocities that exceed 5.0 fps [1.524 mps] must be metallic and manufacturer rated for those flow velocities exceeding 5.0 fps [1.523 mps].
 - c. Check valves must be installed with the valves' flow arrow pointing in the water flow direction.
 - d. Check valves must not be placed in a downward water flow condition.
18. Pipe material transitions:

- a. Material transitions must be above-grade, flange to flange connections, and include ribbed EPDM-type rubber gaskets.
 - b. Dielectric unions must be used when joining dissimilar metallic pipe materials.
 - c. Install dielectric fittings at ferrous and non-ferrous metallic piping.
 - d. Below-grade materials transitions are prohibited without pre-approval.
19. Place pipe couplings, with the welded-water stop plate, into position before placing concrete around such water stop couplings.
- a. Vibratory methods are required when placing concrete at welded water-stop devices.
 - b. Install water stops, waterproofing, flashing flange, or sleeves as detailed on each floor or wall penetration.
 - c. Coordinate water stop couplings installed at the cast-in-place penetration of the pool basin and each penetration of concrete equipment room walls and floors.
20. Do not install low-mounted suspended / hung piping less than 7-feet [2.13 m] above the FFE without This Engineer's written approval.
21. Install Type 3 or Type 5 piping within 6-inches [150 mm] of self-priming pumps.
22. Use only flanged joints, unions, or roll grooved couplings where disassembly is at temperatures above 110°F.
- a. Do not use PVC for threaded connections at temperatures above 110°F

Temperature (degrees F.)	De-Rating Factor
73	1.00
80	0.88
90	0.75
100	0.62
110	0.51
120	0.40
130	0.31
140	0.22

F. WELDED PIPE CONNECTIONS

- 1. Weld symbols shown must be interpreted per ANSI/AWS A2.4. When no weld symbols are specified, welds must be 100% depth and fulfilled with adequately prepared pipe ends in the usual fashion.

2. Refer to the applicable Specifications for PVC pipe welding. At a minimum, perform PVC pipe welding via the hot-gas welding method using a 600° Degree F [315° Degree C] tip temperature, providing a temperature of approximately 500° Degree F [260° Degree C].

G. NON-WELDED PIPE CONNECTIONS

1. Equipment room—located pipe sizes 3-inches [75 mm] and greater must have flanged connections unless otherwise specified.
 - a. PVC piping under basins and other concrete slabs may use solvent-welded connections regardless of size unless otherwise indicated.
2. Pipe sizes less than 3-inches [75 mm] may have NPT threaded connections unless flanged connections are necessary to adapt to other devices.

H. FLANGED PIPE JOINTS

1. Bolt flanges together per recognized standard practice.
2. Provide manufacturer's authorized synthetic non-degradable gaskets at flange joints.

I. THREADED PIPE / FITTING JOINTS

1. When threaded pipe joints and fittings are used, fittings must be minimum Type 2.
2. Assemble threaded joints with Loctite "PST" pipe thread sealant per Loctite instructions. No more than three pipe threads are to be exposed after the joint is made uptight.
3. Do not use threaded-fitting manufactured with Sch. 40 PVC pipe. Only threaded-fittings utilizing PVC Sch 80 or heavier-wall piping is permitted.
 - a. Threaded-fittings requires a 50 percent reduction in pressure rating stated for plain end pipe @73°F.
4. Female plastic pipe threads must only accept male plastic fittings. In male pipe threads of a metal pipe, a metal female fitting must be used. Female metal pipe threads may accept plastic or metal male pipe threads.

J. PIPING ISOLATION FROM CONCRETE FLOORS AND WALLS

1. Install vibration isolators on the suction and discharge piping systems at each pump.
2. Install required Link-Seals with the corresponding Century-Link sleeves at each pipe penetrating equipment room walls, floors, and collector/surge tank concrete for a waterproof seal. Refer to the Drawings for additional details.
3. When Link-Seals are described in detail in the drawings, no substitutions are allowed.

K. FIELD QUALITY CONTROL & WATER PRESSURE TESTING

1. Perform the following piping system hydrostatic water-pressure testing:
 - a. Provide necessary pumps, pressure plugs, caps, gauges, and other instruments and devices necessary to perform the hydrostatic (water) pressure tests specified.
 - 1) Maintain the continual water-pressure test on the piping system throughout the backfill, compaction, deck placement, and construction activities around the piping.
 - 2) Comply with pipe/fitting manufacturers' requirements when preparing for water-pressure testing of a piping system.

- a) Air must be removed from pipes & fittings before water testing.
 - b) Caution: Do not use compressed air pressure on PVC piping or fittings.
- b. The Contractor must provide a water-pressure-test on each piping system to a minimum pressure of 150 percent of the system working pressure except as noted below.
 - 1) Typically, water-pressure tests all piping at 60 psi [413.7 kPa] with the following exceptions.
 - a) Exception: Perimeter overflow (gutter) piping, drain outlet gravity piping, open-channel, and other gravity drain piping: 30 psi [206.8 kPa].
 - b) Underwater light conduits: Water-pressure tested to be leak-proof at 15 psi [103.4 kPa]. Light conduit water-pressure testing is mandatory since such conduits contain pool water in a leak-free condition.
 - 2) The Contractor must provide certified, photo & written documentation upon the completion of these water-pressure tests.
 - a) The written certification must include words stating that “no water was added” to the piping systems during these water-pressure tests.
- c. The Contractor’s required initial water-pressure test duration: Observed a minimum of 24-hours of constant water-pressure without additional pumping or water addition.
 - 1) Before the water-pressure test is considered satisfactory, the water-pressure testing must include a documented visual check of 100% of joints by the Contractor and The Architect and This Engineer to verify that there is no water leaks/water loss.
 - 2) All piping must be maintained in a pressurized condition until all work near the piping is completed. Once the decking is in place over, near, and around the piping systems, a final verified observation of the intact water-pressure testing must be confirmed and recorded. Only then may the water-pressure testing may be removed from the piping systems.
 - a) Only after the decking is placed must the water-pressure test assemblies be withdrawn from the collector, reservoir, and surge tank.
 - b) After the successful conclusion of water-pressure testing, the manufactured-provided valves and related equipment must be installed inside each collector, reservoir, and surge tank.
- d. The Contractor must be responsible for discovering water leaks and making necessary repairs. Water leaks must be repaired and repeatedly tested until leakage or infiltration is corrected, resolved, and approval by This Engineer.
- e. The Contractor must provide coordination and adequate protection as needed for external services (i.e., ducts, pipes, cables) that run throughout the project site. Plumbing must be located and placed to prevent damage during and after the construction of traffic loads above.
- f. The Contractor must confirm a minimum of 7-feet ceiling clearance height between the room’s floor & ceiling and overhead piping, valves, hangers, mounted equipment, etcetera.

L. PIPING SUPPORT, EXPANSION, PROTECTION

1. Under this section, the work-scope consists of furnishing all necessary labor, supervision, and services to execute the pipe hanger entirely and supports as described in this specification.
2. Provide bracing, fasteners, bracing, hangers, supports, and related hardware.
 - a. All piping and significant components must be adequately supported to avoid placing excessive strain on either piping, building structures, or major system components (piping manifolds, pumps, and valves).
 - b. All piping must be adequately supported, isolated, and installed to allow for expansion, vibration, and noise reduction.
 - c. All piping must be supported to prevent sagging. Without exception, the piping must slope as noted herein.
3. No excessive movement by the piping is allowed.
4. After installation, metallic parts must be coated/painted with a primer and an exterior metal coating
 - a. Provide means of preventing dissimilar metal contacts such as plastic-coated hangers, copper-colored epoxy paint, or non-adhesive isolation tape- B-Line Iso-pipe.
5. The piping support details shown in the Drawings are diagrammatic and indicate the general arrangement and methods for providing proper support for piping systems.
6. Due to the small scale of these Drawings, it is not possible to show elbows, and flexible connections specified to allow for expansion and pipe movement; however, the Contractor must verify that adequate expansion and flex capability is achieved while maintaining sufficient supports to avoid placing excessive strain on the piping, building structures, or system components.
7. Install expansion joint assembly units on the suction and discharge of each pump rated at 5-hp [3.72 kW] and larger
 - a. Refer to the Drawings for quantities and sizes
 - b. Install pipe supports and bracing for piping manifolds.
 - c. Install compression sleeves and extension rods
 - d. Pipes located within mechanical equipment spaces, within structures (with no soil support), and on-structure piping must require pipe-support units.
 - e. Comply with local codes and manufacturers' requirements for maximum spacing of hangers and support. Both the pipe manufacturer and the pipe support manufacturer are to be consulted for additional recommendations & requirements.
 - f. Support vertical-piping independently of connected horizontal-piping. Support vertical-pipes on every floor. Wherever possible, accurately locate riser clamps directly below pipe couplings or shear lugs.
 - g. Individually support valves and heavy fittings to avoid stress on adjacent piping or fittings.
 - h. Do not support any equipment from the adjacent piping systems.
 - i. Do not over tighten pipe in supports, preventing the anticipated movement. Install clamps, supports, and straps that hold pipe away from the adjacent framing as part of the base bid.
8. Concrete Inserts:

- a. Provide insert-components for placement in formwork before concrete is poured.
 - b. Provide inserts for suspending hangers from reinforced concrete-slabs and sides of reinforced concrete beams.
 - c. Where concrete slabs form finished ceilings, the Contractor must provide inserts to be flush with the slab surface.
 - d. Provide hooked rods to the concrete reinforcement section for inserts carrying pipe over 4-inches. Coordinate with the project's Structural Engineer of Record.
9. Drawings do not indicate exact-required support details; however, complete piping support is a performance responsibility assigned to the Contractor. Piping and equipment support must be provided as required by the forces and loads and as determined and directed by This Engineer.
- a. The Architect and This Engineer may recommend additional supports to be installed once the equipment is placed into operation. The Contractor must provide such additional strapping, supports, and other such bracing identified by the Engineer at no additional costs.
 - b. It must be the Contractor's responsibility to thoroughly support piping at valves, pumps, equipment, over head-clearance areas, and changes in direction.
 - c. Pipe larger than 12-inches in diameter requires floor supports using stainless steel (or alternative approved materials) support bracing columns.
10. Install additional pipe supports and expansion compensation devices as This Engineer may deem necessary.

M. HORIZONTAL PIPE SUPPORTS

1. Refer to the Drawings and these Specifications for the recommended method of support for horizontally run piping when supported from wall-mounted hangers, floor supported hangers, or ceiling mounted hangers.
2. Install wall-mounted pipe supports at gutter piping around the pool to prevent sagging or dropping of the piping. Refer to the applicable drawing details.
 - a. Exception: If the gutter piping is encapsulated within the structural beam, pipe supports are not necessary.

N. VERTICAL PIPE SUPPORTS

1. Refer to Drawings for vertical pipe support details.
2. Supports for vertical pipe runs must be independent. Install a minimum of 2 supports at each vertical pipe run. Install vertical pipe runs before connecting to the horizontal runs.

O. FLOOR MOUNTED PIPE SUPPORTS

1. Refer to the Drawing details for the floor supports for horizontal pipe runs.
2. For floor construction, other than concrete, a 4-inch [100mm] base plate must be installed and fastened to the floor with sufficient fasteners and spacing appropriate for the floor construction.

P. PIPE RUN ANCHORING FOR DYNAMIC LOADS

1. Install a minimum of one thrust block anchor on each equipment room or vault straight run as close as possible to the downstream elbow. Thrust blocks are not necessary for buried PVC piping located in field-tested & verified compacted pipe trenches.

Q. NOISE REDUCTION

1. Superior noise reduction procedures:
 - a. Isolate piping penetrations from the structure via the use of Link-Seal Penetrations
 - b. Clearances around each pipe at the concrete floor juncture.
 - 1) Utilize a No-Leak Flange (Type 2 piping)
 - c. Install expansion joints/couplings before and after each pump greater than 5-hp or as indicated on the Drawings.
 - d. Install neoprene equipment mounts (for pumps more massive than 5-hp [3.73 kW]) except when their use is contrary to the pump manufacturer's installation requirements.

R. COMPRESSED AIR PIPING SYSTEMS

1. Install only welded metallic fittings and metallic flanged fittings designated explicitly for operations with compressed air.
 - a. Caution: CPVC, PVC, and other Petrochemical type piping systems may not be used for compressed air systems unless expressly authorized in writing by the specific manufacturer.
2. Conduct a 24-hour air-pressure test on compressed air metallic piping and pressure tubing systems at 150% of the operating air pressure (but a minimum 150 PSI).
 - a. The air-pressure test must be applied to the CO2 systems
 - b. The air-pressure test must be applied to the fog/mist systems
 - c. The air-pressure test must be applied to the compressed air pipe systems
 - d. Maintain the air pressure testing until all surrounding work near the air pipes is completed. Provide necessary safety covers/safety mesh to accommodate potential explosion failure of air piping system.
3. During installation, maintain piping systems in clean conditions allowing no debris, dirt, pollutants, or water from entering the piping. Install and maintain temporary piping plugs and threaded caps at the end of each work session.
4. Install metallic piping systems in compliance with the air compressor and receiver tank manufacturers' requirements.

S. COMPRESSED AIR FLEXIBLE TUBING SYSTEMS

1. All tubing for compressed air must include the following documentation from the manufacturer or distributor:
 - a. That the tubing is designed to handle compressed air
 - b. A minimum pressure rating is based on 150% above the operating temperature. The tube pressure rating must be more significant than what the compressor is rated to deliver, and the rated-temperature must be more than 150% of the maximum service temperature
 - c. If installed outdoors, that the tubing is UV-resistant

- d. The type of connections (barbed, compression, or push-to-connect) is best used with that tube (manufacturer's approval is necessary).
2. All points of connection to the tubing must be of a type (barbed, compression, or push-to-connect) approved by the tubing manufacturer or distributor and pressure-rated, as noted above.

3.07 FINISHES & COPING EXECUTION

A. GENERAL

1. Tiles must also refer to designated finishes, natural stone finishes, plaster, screed, and similar materials. Contact This Engineer for written clarifications as needed.
2. The inset step treads, ladder step treads, horizontal surfaces on open gutters & shallow end steps (for entry & exit), and floors (less than 5-feet [1.52 m] deep) on pools must have a slip-resistant surface finish.
3. In all cases where two tiles are installed in a protruding, perpendicular condition resulting in an approximate 90-deg (or similar corner) edges being evident, the installer must provide at least one of those tiles having a bullnose trim.
4. The tile edges (using bullnose, slip-resistant trim tiles) located at gutter lips and step edges are typical details and examples applicable and indicative of all similar tiled conditions.
5. Refer to the Landscape Architect's and Architect's Drawings for additional finish selections and requirements.
6. Indoor and outdoor pool wet decks have a minimum of 2% and a maximum 4% uniform slope away from the pool or related deck-drains, which discharge to the authorized waste outfall.
 - a. Exception: Plunge pool deck may slope toward the plunge pool basin.

B. PREWORK VERIFICATIONS

1. Before commencing any basin interior finishes work, confirm the Site meets the following:
 - a. Concrete work has been performed per the Contract Documents.
 - 1) Water-level structures and related sensitive edges & trims (the gutter edge/lip, infinity edge, and weirs) must be precisely level
 - 2) Exception: The maximum variance from the highest point to the lowest point must not exceed 0.125-inches [3.17 mm].
 - b. Basic basin geometry, dimensions, & elevations are achieved and allow the interior finishes' and coping installation clearances.
 - c. Shotcrete surfaces have been wood floated smooth and are ready to accept the designated finishes.
 - d. Sounding tests have been completed, and any discovered areas of non-binding or voids.
 - e. Concrete has been cured and allowed to set.
 - f. Screed layers are in place, and expansion joints/cut joints of the structure remain exposed.

- g. Movement joints must be placed considering the structural joints' position and to guide the movement joints' dimensional placement. Refer to the maximum separation between movement joints below.

C. ENVIRONMENTAL CONDITIONS DURING FINISH INSTALL OPERATIONS

- 1. Do not commence basin interior or deck finish applications operations unless the following environmental requirements are satisfied:
 - a. Affirm that materials and surrounding air temperatures are higher than 45° F [7° C] before, during, and 7 days after completing tile work operations.
 - 1) Refer to the manufacturers' requirements and installation procedures
 - b. If necessary, during freezing or near-freezing weather, provide equipment and environmental covers and heaters to maintain a minimum of 45° F [7° C] and to protect work completed and work in progress.
 - c. If inclement weather (high winds, rainy weather, or near-freezing temperatures) occurs, a suspension of the finishes' installation work must occur unless This Engineer provides written direction to proceed.

D. PREPARATION

- 1. General
 - a. Prepare tile work, grout, mortars, and plaster per these Specifications, manufacturer's instructions, & TCNA (Tile Council of North America) Standards.
 - b. Any discrepancies between these Specifications and the Manufacturer's Instructions must be immediately brought to This Engineer's attention for written resolution.
 - c. Refer to these specifications for Field Quality Control requirements
 - d. Cut & trim plumbing pipes entering the basin(s) flush with walls and floor surfaces (allowing for the thickness of the new finishes' execution).
 - e. Remove internal blanking disk or pressure plugs after basin construction is complete, but before interior finish work is installed.
 - 1) Before removing the blanking disc or pressure plugs, verify that the specified pressure test was in place per these specifications' requirements.
 - f. Mechanically water-flush plumbing pipes entering the basin(s) with chlorinated water before acid washing the pool(s). Remove chlorinated water before proceeding.
 - g. Wash the entire interior of the basin with a 25 percent solution of muriatic acid and 75 percent water & pH-neutralize, then Brush-Apply to remove any foreign matter and debris. Mechanically scrape the interior of the basin as needed or specified.
 - h. Repair all "weeping" or lesion areas within the pool basin before applying interior surface plaster or tiles.
 - i. Water "weepers" or voids around penetrations in the basins' structure must be sealed with authorized hydraulic, non-shrink cement at least 7-days before cleaning and acid-washing the basin structure.

- j. Before applying the waterproofing & interior finish materials and after a minimum of 28-day curing, dewater, clean, acid-wash, pH-neutralize, thoroughly water rinse, required pressure washing of the entire basin structure's interior surfaces, and compliance with the interior finish and coping manufacturers' instructions & These Specifications.
 - 1) Thoroughly pressure-wash the basin's interior surfaces by utilizing a Turbo-Tip nozzle powered with a minimum water spray of 3,500 psi [24.13 mPa].
 - 2) Scrub basin surfaces with the neutralizing agent to verify acid residues are removed.
- 2. Coping, Deck, Tile, & Natural Stone Finishes
 - a. Follow & observe the tile manufacturer's instructions, recommendations, requirements, & TCNA guidelines & standards.
 - b. Surfaces must be adequately prepared and suitable for installation per the Tile Council of North America (TCNA) guidelines. Substrate leveling must be completed before the installation of all finishes and their adhesives. Do not attempt to re-level or plumb the vertical surfaces during the coping & finishes' installation process.
 - 1) When the basin's interior surfaces and coping are a natural stone material, pre-cast, or tiles, in that case, a leveling screed-type layer must be provided over the structure, top-of-beam, and infinity/weir structures.
 - c. Movement joints for finishes:
 - 1) Mandatory movement joints must be provided in horizontal and vertical planes for the various installations of coping, natural stone, racing lanes, wall & gutter tiles, and similar finishes. Exterior stone installations must have LATASIL sealant (with its appropriate primer) between each stone unit (in each joint)
 - 2) Underwater tile contraction / expansion / movement-accommodation joints:
 - a) Required a minimum of 10-feet [3.04 m] on center except as noted below.
 - b) Movement joints must extend through the screed/setting bed
 - c) Place movement joints at structural contraction, control, and joint expansion locations.
- 3. Exposed aggregate pool finish (quartz-type plaster)
 - a. Since concrete containing Xypex Admix forms a relatively smooth-surface and the resulting crystalline formation fills the concrete pores, reducing the concrete's suction characteristics, it is mandatory to adequately & carefully water-blast/pressure wash and then use a suitable bonding agent for proper bonding of cementitious systems.
 - 1) The entire interior basin surface must be blasted with the pressure-washer operating with a Turbo-Tip nozzle at 3,500 PSI [24.13 mPa].
 - 2) The finishes' installation installer (hired for and paid by the Contractor) must review each crack repair and validate its condition before commencing with each basin & tank's finishes.
 - b. Confirm, verify, and coordinate with the finishes installer that there are no conflicts or physical incompatibility between using the specified waterproofing and the finishes' materials.

- c. Visually check the interior of the basin to determine smoothness and adequacy. When voids or surface irregularities are discovered, or any areas are found that require more than 0.375-inch [10 mm] of pool plaster, such areas must be filled with multiple coats of an approved scratch-coat, preceded by surface treatment, acid washing, and neutralization as specified by the manufacturer. Follow the PermaKote manufacturer's requirements for applied thickness and installation requirements.
 - d. In-Ground/below-grade pool & feature Basins
 - 1) Do not proceed to plaster installation operations until This Engineer has observed the PermaKote installation and verified specific dimensions. The Contractor must apply/provide the PermaKote per the manufacturer's requirements.
 - a) BaseCrete is not required on in-ground, below-grade pool basins.
 - 2) Only after applying the PermaKote, by C.L. Industries, can the Krystalkrete quartz-type plaster be installed/provided to ensure a bond and secure the manufacturer's warranties.
 - e. The Basis of Design for BondCoat: BaseCrete Flexible Waterproof BondCoat system by BaseCrete Technologies, LLC, 6148 Clark Center Ave., Sarasota, Florida 34238; 941-312-5142; www.BaseCreteusa.com
 - f. The Basis of Design for the scratch-coat and bonding warranty use only PermaKote to deliver the manufacturer-required link between adequately prepared substrates and new plaster coats. PermaKote by C.L. Industries, Orlando, FL.; www.clindustries.com
 - g. The Basis of Design for quartz-type plaster: Krystalkrete exposed-aggregate quartz pool finish by C.L. Industries, Orlando, FL.; www.clindustries.com
4. Single Layer EVA-rubber copolymer tile wet area surfacing system
- a. Site Verification of Conditions: Verify that substrate-conditions are suitable for installing the EVA-rubber copolymer wet area surfacing system.
 - b. Do not proceed with such installation until unsuitable conditions are corrected to satisfy the manufacturer's authorized installer.
 - c. Proper drainage is mission-critical to the longevity of the Life Floor® surfacing system. Inadequate drainage may cause premature breakdown of the poured system in affected areas and void the warranty.
 - d. Surface Preparation: Confirm that the concrete, metal, wood, tile, or fiberglass substrate is level or uniformly sloped since surface variations must be telegraphed through to the rubber tile surface.
 - e. Proper drainage is also mission-critical to the longevity of the Life Floor® surfacing system. Inadequate drainage may cause premature breakdown of the system in affected areas and void the warranty.

E. APPLICATION

- 1. Do not apply interior finishes unless the pool fence and gate system are completed. There is a supply of potable water for filling, and permanent electrical power is connected to the filtration system.
 - a. Access through the pool fence from dwelling units is only via a minimum 4-Feet (1.21 m) self-closing, self-latching, lockable gate.
 - b. Exception:

- 1) Instead of a fence, permanent natural or manmade features such as bulkheads, canals, lakes, or navigable waterways adjacent to a pool may be acceptable as barriers when specifically approved by the local government authorities.
- c. A latched, lockable gate must be placed in the fence within 10' (3048 mm) of the closest point between the pool and the equipment area for service access.
2. The interior finish application workmanship must comply with the high-quality, excellent workmanship outlined in the Drawings and these Specifications.
3. Provide work per the Contract Documents and the Manufacturer's instructions & recommendations.
4. Any discrepancies between these Specifications and the Manufacturer's instructions must be immediately brought to the attention of The Architect and This Engineer.
5. Follow manufacturer-directed environmental limitations and curing periods when applying the interior adhesive, finish, and setting materials (an example is air temperature restrictions, rain, and curing times).
6. Tiles, pre-cast, and natural stone:
 - a. Install only frost-proof tiles in locations in which freezing temperatures may occur.
 - b. Smooth exposed cut edges.
 - c. Observe and comply with the manufacturer-stated minimum and maximum limitations concerning grout-joint sizes during the installation of finish materials.
 - 1) The joints' nominal centerline should be accurate, straight, and even complete with due allowances for hand-molded or rustic tiles.
 - 2) Finish floor and wall areas accurately, level, and plumb with no variations exceeding ¼-inch [6.3 mm] (a maximum of 1/8-inch [3.15 mm] from the lowest to the highest elevation and trueness.
 - 3) The grout-joint must be three times the size of the tile's facial dimensional irregularity. Contact This Engineer for further clarification.
 - 4) All materials must be compatible and suitable for submerged locations.
7. Exposed-aggregate quartz plaster finish:
 - a. Towel and finish with a smooth, dense, impervious, waterproof surface, free of stains, and uniform color and consistency.
 - b. The basin's interior surfaces must be plastered in one day. Employ adequate/necessary workforce to accomplish this requirement.
 - 1) One (or multiple) row(s) of 2-inches x 2-inches [50 mm x 50 mm] slip-resistant, separation tiles, "white" color, may be installed in the interior of the basin to be utilized as a joint for the plaster application if the Installer believes that a one-day completion is impractical while maintaining exceptionally high-quality installation practices.
 - c. The installer may install the slip-resistant joint separation tiles, "white" color, in the basin after prior written notification, and submittal requirements are approved herein.
 - d. Basin floors and horizontal surfaces must have a slip-resistant finish and texture.
 - e. No logo, finish, or other tiles/color patterns are allowed on the interior surface that might hinder the detection of a human in distress, the presence of algae or sediment, or other similar objects in the pool.

- f. Single Layer EVA-rubber copolymer tile wet area surfacing system
 - g. Contact the manufacturer for all installation work. Only the manufacturer's certified installers may install this material.
8. Decking (& Wet Decks)
- a. Pool wet decks (& IWF surfaces) must be constructed of concrete or other nonabsorbent material having a smooth but textured slip-resistant finish.
 - 1) The minimum wet-deck width around the pool perimeter is 4-feet [1.21 m] as well as around rails, ladders, & accessibility lift units (ALU), with the following exceptions:
 - a) Pools of less than 120-Square Feet [11 Sq.m] of pool water surface area may have a minimum of 4-feet wide [1219 mm] unobstructed continuous deck around only a minimum of 50% of the pool perimeter.
 - b) Obstructions at the pool perimeter may exist as long as the maximum of 20% percent of the deck immediately along the pool perimeter is not exceeded. No one-obstruction can exceed 10% of the pool perimeter 20-feet (6096 mm), whichever is less.
 - c) Obstructions must have a wet deck area behind or through them, with the near edge of the walk within 15-feet [4.57 m] of the water, except approved slide obstructions must have the near edge of the walk within 35-feet [10.66 m] of the water.
 - d) These obstructions, wet decks less than 4-feet wide, and decks, as described above, must be protected by a barrier designed to prevent patron access.
 - e) Obstructions must not include pool entry or exit locations/points.
 - f) When obstructions exist in multiple areas around the pool, the minimum distance between obstructions must be 4-feet [1.21 mm].
 - g) IWF's may have up to 50% of the perimeter obstructed.
 - h) Wading pools must have a minimum 10-feet [3048 mm] wide deck around a minimum of 50% of the wading pool perimeter, with the remainder of the perimeter deck being a minimum of 4-feet [1219 mm] wide.
 - i) There must be at least 10-feet [3048 mm] between adjacent swimming pools and wading pools.
 - 2) Wet deck area-finishes must be designed for bare feet and similar uses and must be installed per the manufacturer's specifications.
 - 3) Contractor to provide traffic barriers at the wet-deck perimeter edges to prevent the deck's obstruction by vehicles (where applicable).
 - 4) Wooden decks and walkways are prohibited.
 - b. Textured deck finishes that provide pitting & crevices of more than 3/16-inches [4.8 mm] deep that accumulate soil and algae are prohibited.
 - 1) If settling or weathering occurs, causing standing water, the original slopes must be restored or corrective drains installed.
 - 2) When a curb is provided at the pool perimeter, the wet-deck must not be more than 10-inches [254 mm] below the curb (raised beam).

- c. Walkways (wet-deck) must be provided between the pool perimeter, and the sanitary facilities (restrooms) must be constructed of concrete or other approved nonabsorbent material having a smooth, slip-resistant textured finish for the first 15-feet [4.57 m] of the walkway measured from the nearest pool water edge.
- d. EVA-rubber copolymer tile wet area surfacing system (provided over the concrete deck)
 - 1) An NSF-Standard 50 approval & listing is required.

F. PROTECTION OF FINISHED WORK

- 1. Maintain and protect finished Work in a like-new condition until the date of Substantial Completion.
- 2. Do not permit applied work to damage adjacent surfaces.
- 3. AquaBRIGHT® pool finish must not be applied until all work in the pool area has been completed. The filtering system is completely installed, including all plumbing and electrical work, and is ready for water fill start-up.

G. TILES / DEPTH MARKERS / COPING / FINISH REQUIREMENTS:

- 1. General:
 - a. Each horizontal depth, "NO DIVING," and "NO ENTRY" markers located on the deck surface must be 6-inches X 6-inches [150 mm x 150 mm] (or as detailed on the drawings) and be made of an impervious, slip-resistant, & textured material. Tile lettering must be a minimum height of 4-inches [100mm] and contrast to the background.
 - b. Install a minimum of 2-inches [50 mm] full, dark contrasting, slip-resistant tile marking at the following locations (Note: Refer to the Drawings for specified tile sizes and the number of rows/dimensions of spaces/surfaces to be covered).
 - 1) gutter lips at the upper perimeter of the beam
 - 2) gutter lips and along the horizontal and vertical edge surfaces of steps & risers
 - 3) along the horizontal and vertical edge surfaces of shallow-end stairs/steps, sun shelf edges, and underwater bench seats
 - a) Exception: A sun shelf must have a dark contrasting, slip-resistant tile marking at the edge of the shelf and the pool wall extending 4-inches (102 mm) from the horizontal shelf edge surface.
 - 4) at lap lane floor/wall tiles and targets
 - 5) around the perimeter edge of each inset wall step
 - c. Refer to the Landscape Architect's or Architect's finishing Drawings' details and schedules for sizes, dimensions, and color.
 - d. Impervious, slip-resistant, & textured finishes are required at all:
 - 1) Coping surfaces
 - 2) Horizontally-placed & slope-surfaces' finishes, all markers tiles, step-edge, & gutter lip tiles without exception
 - a) Caution: Bullnose type tiles are prohibited unless specifically approved by The Architect and This Engineer.

- e. Markings are tile and must be flush with the surrounding area and recessed as necessary to provide a smooth, flush finish that avoids creating an injury-hazard affecting bathers.
 - 1) Pools that are not conducive to tile can employ other equivalent markings, as stated in the item above. Contact This Engineer for detailed approvals.
- 2. Depth Markings:
 - a. Place permanent tiled depth and "NO DIVING" markers per the Drawings. Additional markers must be positioned to maintain a maximum of 25-feet [7.6 m] spacing between tiled markers, and markings must be installed:
 - 1) On both sides of the pool at the shallow end,
 - 2) At the slope break, at the deep-end wall,
 - 3) At the deep point (if located more than 5-feet [1524 mm] from the deep-end wall),
 - 4) On both sides of a river pool (outside perimeter and inside the river's perimeter)
 - 5) And as specified by the LGA codes.
 - 6) Exception: A spa-type pool of 200 square feet or less is not required to have depth markers.
 - 7) Exception: The NO DIVING markers are not required at the approved diving bowl perimeter only.
 - b. The horizontal depth and NO DIVING markers (to match the vertical wall-mounted markers) at the basin's edge must be within 2-feet [610 mm] of the water's edge and certified impervious, slip-resistant, & textured.
 - 1) When an elevated curb is provided, depth markings are located inside and outside or on top of the pool curb.
 - 2) When no curb is provided, depth markings must be located at or above water level on the inside vertical pool wall, the outer perimeter of a river pool, the inner perimeter of a river pool, and the wet deck (within 2-feet [610 mm] of water edge).
 - 3) When open-type gutters are used, depth markers must be installed on the back of the gutter wall.
 - 4) When a coping stone with a curved or angled underside is provided, the depth markings are to be installed on the curved, angled coping underside and outside or top of the pool curb.
 - 5) Exception: Where a sun shelf is installed, wet deck-located depth and "NO DIVING" markers must be placed every 20-feet [6096 mm] or less.
 - 6) Exception: Depth and "NO DIVING" markers are not required on wading pools.
 - c. Deck-level perimeter overflow systems:
 - 1) Additional Depth markers must be provided on adjacent fencing or walls, large sufficient to be recognizable from inside the basin.
 - 2) Horizontal depth markers on the deck must be within 3-feet [915 mm] of the water's edge and be slip-resistant.
 - 3) Vertical depth markers may be at the top of the pool wall just beneath the water level. Contact This Engineer for clarification if needed.

- d. Depth markings must be located to depict the basin's water depth within 3-inches [75 mm].
 - 1) Measure the water depth at a location 3-feet [920 mm] horizontal from the vertical wall depth marking.
- e. The depth at the basin's deepest point (drain assembly grate) must not deviate more than 3-inches [75 mm] from the water depth (when measured at the wall) markings at that location. The drain grates must be located at the deepest end.
 - 1) Symmetrical pool designs with the deepest-water depth located at the center must have a dual marking indicating depth at the wall and the deeper position, followed by feet (FT), inches (INCH), or meters (M).
 - 2) Metric Depth markings must have an accuracy of 2 decimal places to assist in this requirement.
 - 3) The only authorized abbreviations for "feet" and "meters" must be "FT" and "M," respectively.
 - 4) Sun shelf depth markers:
 - a) If the vertical distance between the coping or wet deck and the sun shelf floor adjacent to the wall is 12-inches [305 mm] or less, these markers must indicate the sun shelf's water depth.
 - b) For open-type gutter pools, the vertical distance must be measured from the gutter lip to the shelf floor.
 - c) When the vertical distance between the coping or wet deck and the sun shelf floor adjacent to the wall is more than 12-inches [305 mm], "No-Entry" markers, slip-resistant, must be provided in the wet-deck.
 - d) When a sun shelf doesn't use stairs for the vertical transition, depth markers (of the adjacent pool depth at the sun shelf edge) and "NO DIVING" markers must be placed on the sun shelf floor, every 10-feet [3048 mm] or less, along a line no more than 1-foot [305 mm] from the edge of the sun shelf above the deeper pool water.
- 3. "NO ENTRY" markings must be slip-resistant and are:
 - a. Required at the perimeter of each water feature or fountain not intended or approved for swimming or bathing, per the drawing details.
 - b. Required at locations around the pool perimeter where entrance into the basin water is disallowed.
 - 1) Critical: "NO ENTRY – SHALLOW WATER" signs must be provided along the pool wall edge where the water depth is less than 3-feet [914 mm] deep. No entry signs must be slip-resistant, have 4-inch high (102 mm) letters, located within 2-feet [610 mm] of the pool edge, and spaced no more than 15-feet [4572 mm] apart.

H. COPING

- 1. Coping and Coping Joints:
 - a. Coping edges must comply with the Local Building Codes and the following minimum standards:

- b. Precisely level setting beds must be in place before installing coping units, level-sensitive edges, and weirs. Observe the installation requirements for adhesive/grout placement.
 - 1) Modify the setting beds to accommodate sloped coping units
 - c. Jointed concrete coping must be "square-shaped"; however, no poured in place concrete coping length must exceed 125% of the coping width.
 - 1) Exception:
 - a) Pre-cast coping units are exempt from this requirement.
 - d. Provide expansion/movement joints (0.5-inch [13 mm] wide minimum – or as noted explicitly in the Drawings) no more than 20-feet [6.09 m] OCEW. Do not span expansion joints with reinforcing materials. Protruding and angular turns must have expansion joints.
 - e. When the coping is cast-in-place materials:
 - 1) Locate cut joints no more than 5-feet [1.53 m] OCEW. Cut joint depth must be 25% of the pour depth. Execute the placement of cut joints within 1-hour after coping placement.
 - 2) Install plastic tile separation strips between the poured-in-place cantilever beam coping and the uppermost portions of the tiles.
 - 3) Extend the expansion/movement joint through screed/setting materials
 - f. Isolation joints (0.5-inch [13 mm] wide minimum – or as noted explicitly in the Drawings) must be installed between each basin beam (coping) and the adjacent pool deck and paver units.
 - g. Underwater expansion joints must be installed with approved primer and closed-cell backer rods (or the specialized Emseal [or Willseal] Joint).
2. For re-entrant corners, provide:
- a. 2 - #4 [13M], Grade 60 [420], 30-inches [760 mm] long rebars in the new decking before placement
 - 1) locate one rebar 2-inches [50 mm] from the re-entrant corner
 - 2) Locate one rebar 5-inches [125 mm] from the re-entrant corner.
 - 3) Provide a minimum 2-inches [50 mm] radius on all protruding coping edges.
 - b. 45-degree positioned rebars 2-inches [50 mm] deep within the concrete coping (as the concrete is being placed).
 - c. A cut-joint between protruding, 90-deg (or higher) corners and the closest deck-located expansion/cut joint.
- I. GRATING
- 1. Install per manufacturer's instructions.
 - 2. Install grates after the danger of damage from construction traffic is passed.
 - 3. Attachment of the grate frame units must not have a solid-surface, constant-angle (slotted openings are mandatory) SST to allow water to pass around and through the grating.

4. A gap space target of 0.375-inches (unless disallowed by the Drawings) is required between the outermost basin wall structure and the grate framing to allow water to pass through and around the grating.
 - a. The Contractor must provide stainless steel spacers at the grating perimeter to ensure a uniform installation spacing gap.
 5. Grating frames and attachments must be sized to minimize water splashes without exception.
 6. Pool-edge plastic-type grating must be of the parallel type without exception.
 7. The grates must be lockable and not removable by unauthorized persons.
 8. Clean promptly after installation per the manufacturer's instructions.
 9. Do not use harsh cleaning materials like an acid wash that could damage products.
- J. CONCRETE TOPPINGS, RESURFACING, AND REHABILITATION
1. Surface preparation
 - a. Follow the manufacturer's instructions & recommendations, and requirements.
 - 1) Areas needing repairing must be clean, sound, and free of contaminants.
 - 2) Loose and deteriorated concrete must be removed by using mechanical means.
 - 3) Mechanically prepare/treat the concrete substrate to obtain a surface profile of +/- 1/16-inch (CSP 5 or higher as per ICRI Guidelines) with a newly exposed aggregate surface.
 - 4) Areas to be addressed/patched must be a minimum of 1/8-inch [3 mm] in depth.
 - b. Refer to these specifications for procedures specified if reinforcing steel with active corrosion is encountered
 2. Mixing and application
 - a. Placement Procedure:
 - 1) At the time of implementation, the substrate should be saturated surface dry with no standing water. Scrub mortar or concrete into the substrate, filling pores and voids.
 - 2) While the scrub mortar coat is still plastic, force material against the edge of repair, working toward the center. If the repair-area is too large to fill and the scrub coat is still wet, use Sika Armatec 110 EpoCem in place of the scrub coat (See Spec Component SC-200); www.usa.sika.com.
 - 3) After filling, consolidate, then screed. Allow mortar or concrete to set to the desired stiffness, then finish with trowel, manual, or power for a smooth surface. Utilize a soft-broom, burlap, or similar technique-drag to create a textured surface.
 - 4) When the proposed repair's depth is less than 1-inch [25 mm], the repair must be renovated/treated with polymer-modified Portland cement mortar. When the repair's depth is more significant than 1-inch [25 mm], the repair must be made with polymer-modified Portland cement concrete.
 - a) Per ACI-recommendations for Portland cement concrete, curing is required.
 - b) To prevent freezing, cover with the insulating material.
 - c) Setting-time is dependent on temperature & humidity.

3.08 BASIN & SITE EXECUTION

A. BASIN STRUCTURES:

1. For basin structures that are larger than or equivalent to 3,000 sf [278.7 square m], the basin floor must be poured-in-place (also known as “cast-in-place” or C.I.P.) concrete with shotcrete walls.
2. For basin structures placed as an integral unit (no joints), then verify that the wall/floor radius complies with the radius transition table below:

Water Depth (feet) [m]	Radius transition to floor (inches) [m]
3 [0.91]	6 [0.15]
4 [1.22]	9 [0.23]
5 [1.52]	12 [0.30]
6 [1.83]	18 [0.46]
8 [2.44]	24 [0.61]

3. Basin wall – vertical nature:
 - a. The basin wall must be within 5-degrees of vertical for at least 2.5-feet [760 mm]. The radius connecting this upper section of the floor must not exceed the following.
 - 1) If the upper part of the wall is in a basin area that is greater than 5-feet [1.53 m] deep, then the walls must be vertical within 5-degrees to the commencement of the radius scheduled.
 - 2) Maintain vertical wall angles (within 5-degrees vertical) for a minimum depth equivalent to the basin depth minus 2-feet [610 mm] to start the radius to the floor. Refer to the Drawings for additional dimensions.
4. All Basin Structures:
 - a. Infinity edges, trims, and weirs: Contractor must provide in a “performance-based means & methods” excellent water-appearance & water-level sensitivity, water-flow-sensitive infinity edges, trims, and weirs. These surface-edges must be precisely level to create and deliver consistent, smooth water appearances & water-flows with minimal water-splash.
 - 1) Exception: The maximum variance from the highest point to the lowest point must not exceed 0.125-inches [3.17 mm].
 - b. Caution: Critical Contractor-responsibility requires excellent supervision and workmanship at all infinity-surface edges, infinity-trims, weir surfaces, drip-strips, and related unit joints.
 - 1) No irregularities are allowed at the weir, unit weir-spacing joints, or the grout joints.
 - 2) Corner joint-splices are critical on all such surfaces. They frequently cause unacceptable water flow creating water splashing at the basin or grate surfaces due to dangerous or irregular joint geometry.
5. Remedial procedures for concrete & structures:

- a. System Description
 - 1) Install reinforcing steel dowels, threaded anchor rods, and inserts into concrete with injectable adhesive.
 - 2) Use only injection tools and static mixing nozzles supplied by the manufacturer.
 - 3) Install per manufacturer's instructions.
6. Install pool accessories and fittings per the component manufacturer's instructions and with the Contract Documents.
7. Refer to the Landscape Architect's and the Architect's drawings for additional:
 - a. shower details
 - b. deck finish & installation details and its drainage
 - c. planter details
 - d. bridge details:
 - 1) Bridges and overhead obstructions over the pool must be designed to prevent or introduce contamination to the pool water.
 - 2) Bridge or obstruction over the pool is at least 4-feet [1.21 m] above the pool's water surface in all cases except when the pool is a river ride where it must be at least 5-feet [1.52 m] above the surface of the pool.
 - 3) Minimum 42-inches [1.06 m] high handrails are provided along each side of the bridge
 - 4) The bridge or walkway footing surface must be constructed of concrete or other non-absorbent material having a smooth, slip-resistant finish. Pool coping cannot overhang into the pool more than 1.5-inches [38 mm].
8. Pool Basins Only:
 - a. Minimum vertical clearance above water and deck is 7-feet [2.14 m]
 - b. Protruding corners and edges
 - 1) The inward and outward protruding coping edges, basin wall edges, corners, step risers, benches or shelves, and ledges must have a minimum radius of 2-inches [50 mm].
 - c. Floor / wall / step / bench depth requirements:
 - 1) The minimum pool water depth located for the shallow end of a pool must be 3-feet [915 mm].
 - a) Exception: Zero-entry pool depth is: 0-feet [0 m]
 - 2) The minimum pool water depth for the deep end of a pool must be 4-feet [1.22 m].
 - 3) Pool corners angle: minimum 90-degree angle.
 - 4) Underwater bench or ledge dimensions:
 - a) Width: minimum 14-inches [355 mm] and maximum is 18-inches [455 mm]
 - b) Depth: 20-inches [500 mm] and maximum 22-inches [560 mm] below the waterline
 - c) Underwater bench seats are in pool locations, which are less than 5-feet [1524 mm] deep.

- d) Benches must not protrude into the 15-feet (4572 mm) clearance requirement.
- 5) Step edge/bench edge nosing tiles must consist of slip-resistant tiles that are a Munsell color value from "zero" to "four," contrasting with the interior of the pool (and gutter) surfaces. Refer to Drawings for the configurations.
- 6) Install underwater step risers with uniform dimensions indicated on Drawings. A maximum of 0.25-inch [6.3 mm] (from the highest elevation to the lowest elevation) construction deviation is allowed.
 - a) The entrances and exits to the pool basins (and spa basins surface areas larger than 200 sq. ft.) must incorporate a maximum step riser of 10-inches [250 mm]. The Contractor must add additional steps/risers to achieve compliance with the 10-inch [250 mm] maximum riser height.
 - b) The top riser and lowest riser must be equal in height, while intermediate risers must be equal in height.
 - c) Exception: The Contractor must verify that the applicable Building Codes do not require more stringent requirements. Notify this Engineer for clarification.
- 7) Minimum step-tread width: 12-inches [305 mm] or as dimensioned on the Drawings. Treads, horizontal surfaces, and nosing edgings must be slip-resistant.
- d. The maximum basin water depth at which underwater benches or ledges may be located is 4-feet -11-inches [1.5 m].
- e. Standard basin operating water levels:
 - 1) Skimmer basins: 4-inches [100 mm] below the top of the waterline wall tiles or the middle of the skimmer's throat opening.
 - a) the coping edge (serving as a handhold) must be within 9-inches [230 mm] of the pool waterline
 - 2) Perimeter gutter basins: Level with the tiled gutter-lip edge.
 - a) The maximum gutter-level deviation is 0.25-inch [6 mm] (from the highest point to the lowest point).
- f. Basin floor slopes and slope transition/change requirements:
 - 1) Any transition in floor slope must occur at a minimum water depth of 5-feet [1.53 m]
 - 2) Floor slope-transitions must have a black color, slip-resistant tile as noted:
 - a) Tile size: minimum 2-inches [50 mm] to maximum 6-inches [150 mm] wide provided across the bottom and extend up both sides of the basin walls.
 - 3) Provide a blue and white safety rope line mounted located as noted:
 - a) Rope diameter: 0.75-inch [20 mm]
 - b) Rope location: 2-feet [610 mm] before the slope change (toward the shallow end). Provide permanent wall anchors located to position & secure the safety rope as required.
 - c) Each safety rope line must have multiple floats located a maximum of 7-feet [2.14 m] apart
 - 4) Floor slopes:

- a) Minimum continuous floor slope: 1 unit of depth change for every 60 units of horizontal distance, but reduced to 1 on 50 for IWFs.
 - b) Maximum continuous floor slope: 1 unit of depth change for every 10 units of horizontal distance.
 - c) Maximum floor slope for ADA compliance in a zero-entry: 1 unit of depth change for every 12 units of horizontal distance
 - d) Flat landing area: Incorporate minimum 5-feet long x 5-feet wide [1.53 m x 1.53 m] landing area. Minimum 24-inches [610 mm] and maximum of 30-inches [760 mm] depth in this area
 - e) Floor slope continuation: Floor slopes must be continuous to the water depths indicated in the drawings.
 - f) The floor slope must be a maximum 1-foot [300 mm] vertical in 3-feet [914.4 mm] horizontal in areas more than 5-feet [1524 mm] deep.
- 5) Deck slope of a "wet deck" around a pool or "interactive water feature" must be 2% to 4% toward the drains unless This Engineer provides specific written approval.
- a) All such wet-deck must be concrete or other nonabsorbent material with surfaces having a smooth, slip-resistant, textured surface, and must be installed following the manufacturer's specifications.
 - b) Spray features located in the pool deck must be flush with the pool deck and designed & installed with the pool patron's safety in mind.
 - c) Wooden decks and walkways are prohibited.
 - d) Exception: The pool's wet deck may slope toward the zero-entry grate trench for no more than 7-feet [2133mm], as measured from the overflow system grate outward. Beyond this area, the wet deck must slope away from the pool at 2% to 4% to deck drains.

9. Spa basins only:

- a. Spa-type pools must not have a minimum water depth of less than 2.5-feet [762 mm] and a maximum water depth of 4-feet [1219 mm]

10. Wading pool basins only:

- a. The Wading Pool and its associated piping must not be physically connected to any other swimming pool(s) and have no minimum width requirements.
- b. Wading pools must not exceed a maximum depth of 2-feet [610 mm]. The water depth at the wading pool's perimeter must be uniform and must not exceed 12-inches [305 mm].

B. BASIN FLOOR DRAINS, RELIEFS, & SUMPS EXECUTION

1. General:

- a. Protect the finish surfaces quality appearance of all equipment and components to provide to the Owner in new & pristine condition.

2. VGB grates for floor drains, wall drains, sensors, static fitting, & equalizers:

- a. Locate the static wall fittings, sensors, skimmer equalizer fittings at least 12-inches [305 mm] below the water level.

- 1) Cover with a VGB compliant grated-fitting at the basin wall and basin floor juncture (refer to the Equipment Schedule).

3. Drains – Grates & Sumps

- a. The basin drain system must be sized to allow 100% of the design flow through the piping system such that the flow velocity through the openings of the main drain grate does not exceed 1.5-feet per second [457 mm per second] at the design flow rate of the recirculation pump(s) including flows from related equalizer fittings.
- b. The Contractor must provide the drain assemblies, quantities, and sump models/sizes specified herein.
- c. Each drain assembly grate must be securely fastened (per the manufacturers' approved installation requirements), requiring the use of a tool to remove.
- d. Compliance with VGB is mandatory, along with ANSI/APSP-16 and the water velocity above.
- e. Pools over 30-feet (9144 mm) wide in the deep end must have multiple main drain grates, equally spaced from the pool side-walls and each other.

C. BASIN PERIMETER GUTTER, SKIMMERS, & INLETS EXECUTION

1. General:

- a. Protect the finish surfaces quality appearance of all equipment and components to provide to the Owner in new & pristine condition.
- b. Perimeter overflow systems are required on pools unless expressly noted in the Drawings. Refer to the below type of pre-approved gutter systems. All gutter type systems must comply with the local governmental requirements.
 - 1) Exception: Perimeter Skimmer-type systems (see below) are allowed only in certain specialized circumstances. Refer all questions to This Engineer.
- c. Gutter grates placed over a void or formed channel or pipe opening directly into the beam structure are prohibited.
- d. Gutter drain fittings must be positioned as indicated in these sheets but must not exceed a maximum of 10-feet [3.05 m] of separation unless otherwise explicitly noted in The Drawings.
 - 1) Note that the number of gutter fittings specified must also impact the sizing of the related gutter piping.
 - 2) The back of the gutter drains must be located within a maximum 3/4-inch [20 mm] and a minimum 1/4-inch [6 mm] of from the tiled, back vertical wall of the gutter, where the gutter is deepest and must be flush with the surrounding surfaces or be recessed no more than 3/8-inch [9 mm].
- e. Gutter and Rim-Flow systems must be sized to accommodate 100% of the recirculation filtration flow and discharge into the related collector/surge tank.
- f. Unless noted otherwise, locate a minimum of one air vent connected to the gutter piping system. Refer to the drawings for the location and quantity of the specified air vent(s).

2. Open Gutter:

- a. Install to be a minimum of 12-inches [305 mm] wide (critical).

- b. Slope down 2-inches [50 mm] (critical) from the lip of the gutter to the gutter drain fitting elevations, which must be 6-inches [150 mm] deeper than the gutter lip.
 - 1) Exception:
 - a) Gutter slope must be reduced to only 1-inch [25 mm] in the areas of shallow-end steps.
 - b) The gutter area nearest the top step locations must slope 1-inch [25 mm] from the gutter's lip to the back of the gutter trough and gutter drain fittings. The Contractor must provide a 24-inches [610 mm] transition distance from this slope.
 - c. The bottommost portions of the gutter must be level and finish flush with the gutter fittings. No "dips" or irregular surfaces must be approved at the gutter fittings' junctures with the interior finishes.
- 3. Recessed Gutter:
 - a. Minimum 4-inches (102 mm) deep and
 - b. 4-inches (102 mm) wide.
 - c. No part of the recessed gutter must be visible from a position directly above the gutter, sighting vertically-down the adjacent deck's edge or curb.
- 4. Deck-Level, Rim Flow:
 - a. Horizontal surfaces surrounding the grating must be slip-resistant / non-slip/slip-resistant.
 - b. The grating must be lockable in place and secured by stainless steel hardware. The Contractor must provide access locations for cleaning and maintenance to the perimeter trench at the deck-level, rim-flow grate at the wet deck.
 - c. Colors Selected by Owner.
 - d. Fiberglass parallel trench grating: Before the structure's placement, place the trench within the concrete pool beam structure, connect gutter piping, and extend to the collector/surge tank.
 - e. Rim-flow (deck level gutter systems) require that an overflow fitting (draining to waste) be placed a minimum of every 30-feet [9.14 m] to assist in preventing excessive water spillage to the deck.
 - 1) Rim flow systems require a surge tank with excess capacity (refer to the Drawings) to minimize displaced surge water loss.
 - 2) Overflow fitting(s) must be mounted must in the gutter at an elevation 0.50-inch (12mm) above the operating water level.
 - a) Unless noted otherwise, extend the drain piping from each overflow fitting to the authorized wastewater outfall.
 - 3) Occurrences such as bather-induced splashing/waves, windy conditions, and similar events must result in pool water spilling onto adjacent decks.
- 5. Skimmer installation requirements:
 - a. Refer to the Drawings for details and the size of the pool on which the skimmers are positioned.
 - b. At least one skimmer unit must be provided for every 400 square feet [37 m²] of pool surface area (or a significant fraction) specified by the drawings.

- 1) The design pattern for pools with skimmer must be 100% water flow through the drain system, and 80% water flow through the skimmer system.
- 2) For each skimmer installed, provide one wall inlet on the opposing pool wall (within a maximum of 20-feet [6.10 m] of the related skimmer unit).
- 3) Skimmers and nearby inlets' location must be such that adjacent inlets and skimmers' interference is minimized.
- c. Refer to the Drawings for construction details of the thickened pool beam specified around each skimmer and concealed vacuum unit.
 - 1) To further assist in leak prevention and longevity, the Contractor must provide a steel rebar connection and total concrete encasement of each skimmer unit. Refer to the Drawings.
 - 2) The skimmer unit must not protrude into the pool but be mounted with a tiled throat recessed 6-inches [150 mm] minimum from the inside pool wall as per the Drawings. The skimmer's tiled throat opening must be 18-inches [455 mm] wide minimum at the pool wall as per the Drawings.
- d. Provide tiles around each skimmer throat as noted
 - 1) 3-inches [75 mm] minimum tiled around the skimmer face opening at the pool wall juncture.
 - 2) 100% tiles around and covering the entire skimmer throat.
6. Deck-level grating, waterproof channel trenches, & deck-boxes:
 - a. Refer to the Drawings and Equipment Schedule for geometric sizing, pipe connections, removable trench-access locations, water-proofing provisions, & crack-resistant qualities.
 - b. Concrete formed and poured trench channels are prohibited due to their propensity to crack and leak.
7. Indirect / concealed vacuum assemblies:
 - a. Refer to the Drawings for detailing. Vacuum fittings must be mounted no deeper than 15-inches [380 mm] below the water level, flush with the pool walls, and provided with a spring-loaded safety cover must be in place at all times when the pool is not being vacuumed.
 - b. Install a skimmer lid (or approved similar part) at the deck level opening.
 - c. Provide a 2-inches [50 mm] equalizer pipe from each concealed vacuum fitting assembly to the basin wall and terminate the pipe with an equalizer/safety drain cover.
 - 1) Locate this equalizer at least 12-inches [305 mm] below the water level.
 - 2) Provide a VGB compliant safety cover over each equalizer pipe outlet as noted in the Equipment Schedule
 - d. In multiple vacuum assemblies, obstruct the water flow to units not in use via bulkhead fittings.
 - e. Provide a filtered, chemically-treated water piping connection (per the drawings) to the concealed vacuum unit to prevent stagnant water.

- f. Piping connections towards the vacuum pump must originate within the concealed vacuum assembly body. Direct connections between the vacuum pump and wall inlets or fittings are disallowed.

8. Inlets/nozzles:

- a. The inlet piping system must be looped to confirm continuous, closed water recirculation, ensuring that the inlets must demonstrate equal/similar water flow operations. The maximum water flow per inlet must be no more than 20 GPM.
 - 1) The Contractor must provide additional floor inlets to the sun shelf area as detailed in the Drawings to achieve a 60-minutes water turnover in the sun shelf space.
 - 2) Additional floor inlets must be provided in pool areas having less than 18-inches [475 mm] of water depth. The numbers and locations of such inlets must be such as to double the water flow rate into the shallow-water areas
 - 3) The total pool-filtration water turnover rate must include a minimum of 1 turnover per 2 hours in areas less than 3-feet [914 mm] deep – this applies to zero-entry spaces.
- b. When only wall inlets are specified, they must be spaced no more than 20-feet [6.10 m] apart (or as indicated in the drawings). When wall & floor inlets, refer to The Drawings and the requirements below.
 - 1) Exception:
 - a) Some manufacturers have developed specialty wall inlet fittings that distribute filter water far out into the pool body. Those fittings are permissible with the joint agreement of the local health department.
 - b) The water flow & performance for these specialty fittings must be determined by the individual manufacturer(s).
 - c) Pools/spas less than 20 square feet must a minimum of two inlets
 - 2) Pools having a width of 30-feet [9144 mm] or less, with floor inlets only, have inlets located such that they are not over 20-feet [6096 mm] apart nor over 10-feet [3048 mm] from adjacent walls.
- c. Each wall inlet must be directionally adjustable and located 12-inches [305 mm] min below the water level.
- d. Each inlet/nozzle must be installed level and flush with the adjacent floor, wall, or deck surfaces. No sharp edges or irregular surfaces are permitted.
- e. Each floor inlet must be equipped with a method for flow adjustment.
- f. Maximum water-exit velocity for pool-related and IWF-related feature nozzles and inlets must not exceed 20-feet per second [6.096 m per second] such as not to harm the patrons unless such velocity is justified by the design engineer and by the fountain system manufacturer.
- g. Wading pools with 20-feet (6096 mm) or less perimeter must have a minimum of two equally spaced adjustable inlets.

D. RAILS, LADDERS, ACCESSIBLE LIFT UNIT, & ANCHOR INSTALLATION

1. General:

- a. Ensure pools and spas have a means of access (entrance & exit) every 75-feet using ladders, grab rails, sun shelf(s), and shallow-end stairs/steps
 - 1) Refer to the Drawings for the pool & spa stairs/step's dimensions. Include slip-resistant horizontal surfaces with slip-resistant, contrasting color tile lip-edges on all stairs/steps and sun shelf(s).
 - b. When the deep-end is more than 30-Feet [9.14m], there are ladders or grab rails on each side
 - c. Observe the manufacturer's installation instructions & recommendations and This Engineer's Drawings strictly.
 - d. Stainless steel rail-goods and fountain equipment must be installed no more than 30-days before filling the basins to protect the stainless-steel components.
 - e. The Contractor's responsibility is to protect the stainless-steel equipment's finishes and appearance as like-new without exceptions.
 - f. Each grab rail, handrail, ladder, lift unit (ALU), and rail (these items are hereafter referred to as "rails") must be new and pristine in appearance.
 - 1) Rusty, damaged, stained, or discolored rails must not be accepted.
 - 2) No rail installed in a distressed or "crooked" manner must be accepted.
 - 3) The Contractor must replace such rails as directed by The Architect and This Engineer.
 - g. Install each rail or ladder in an exact vertical and horizontal (level) manner per the drawings' requirements.
 - h. Install rails with the manufacturer's compression anchor sockets.
 - i. Fill the first 12-inches [305 mm] of each rail with non-shrink grout.
 - j. Secure deck anchor with a concrete-anchor mass of 3,000 psi [210.9 kg/cm²] or as detailed on Drawings.
 - k. Equipment must be installed secure, with no "play" or movement when shaken.
2. Handrails for Pools, Spas, & Wading Pools:
- a. Handrails must be anchored on the deck and the lowest pool step (bottom step). Handrails longer than 9-feet [2.74 m] must have additional vertical rail supports.
 - b. A handrail must be provided where stairs (risers/treads) are used as an access point between a sun shelf and pool area. The handrail must be anchored into the bottom step and the sun shelf floor.
 - c. For open gutter pools, where the gutter surface is used as a step, additional steps are not be required when the vertical distance from the gutter lip to the shelf floor is 10-inches [250 mm] or less; however, at least one compliant handrail must be provided at the sun shelf.
 - d. The Wading Pool floor must not be more than 12-inches [305 mm] below the deck unless steps and handrails are provided.
3. Ladder:
- a. Install the ladder between 3-inches [75 mm] and 6-inches [150 mm] of the pool wall.
 - b. Install multiple 6-inches X 6-inches [150 mm x 150 mm] white tiles at the basin wall's juncture and ladder bumpers.
 - c. Ladder treads must be slip-resistant.

4. Grab Rails & Inset Steps:
 - a. Construct inset-steps to be flush with the interior pool wall. No inset-step protrusions into the basin areas are allowed
 - b. Inset step treads must be slip-resistant.
5. Rails – Other:
 - a. Install volleyball rails, sports' rails, and stanchions per the Drawings'.
 - 1) Provide all deck anchors as compression type
6. Accessible Lift Unit (ALU): The Contractor must:
 - a. Provide sufficient deck-space for the ALU rotation as detailed on the Drawings and from the ALU manufacturer. A minimum of 4-feet [1.21m] of the deck behind the lift mount is mandatory.
 - b. Secure all anchor rails and ALU equipment to the reinforced ballast anchors located below the decking per the Drawings. Install with approved compression anchors or sleeves as recommended by the rail / ALU manufacturer.
 - c. Install each ALU's cold water supply pipe into a valve deck box equipped with a lockable cover.
 - d. Extend ALU lift unit's pipes to the mechanical pool room per the Drawings and connect to the potable cold-water supply.
 - e. Provide the required concrete mass anchor for each ALU unit per the Drawings
- E. SAFETY EQUIPMENT, SIGNAGE, AND POSTS
 1. Safety equipment:
 - a. Refer to the Drawings' Equipment Schedule for Contractor-provided safety equipment & signage.
 - b. Pools that are 50-feet [15.24 m] or less in length must have a minimum of 1 safety equipment set; pools greater than 50-feet [15.24 m] in length must have a minimum of 2 safety sets equally-spaced around the pool basin.
 - 1) Securely attach the safety throw rope to each life ring unit (minimum of 18-inches [450 mm] diameter). The safety throw ropes must be sufficient to reach all parts of the pool from the deck. Each safety set must be mounted along each of the longer sides of the pool.
 - 2) Attach life hook to the 16-feet [4.87 m] long pole with stainless steel hardware.
 - c. Mount safety equipment items onto a pressure-treated post or wall-mounted hangers with stainless steel hardware as indicated in the Drawings. Refer to the Landscape Architect for final post finishing details.
 - d. Install a 2.5-inches [63 mm] diameter, with a UV-protective coating, Type 2 pipe for safety pole mounting. Install with stainless steel brackets and hardware at locations shown on Drawings.
 - e. Provide crushed stone 6-inches [150mm] deep at finish grade around each equipment post.
 - 1) Compact soils around and beneath posts to a 95 percent modified Proctor standard.
 2. Safety Signage

- a. Install rules and regulations signage for bathers near the poolside, visible from each pool and pool deck area. Each safety sign must be illuminated with a minimum of 3-foot-candles of lighting levels. Refer to the Architect for illumination design.
- b. The Contractor is responsible for providing & installing safety signage without exception and must confirm:
 - 1) Governmental-required rules are incorporated into the signage.
 - 2) For slides and wet-play equipment: Refer to the respective manufacturer for the rules and signage required.
3. Restroom directional signage
 - a. Install restroom directional sign at the location indicated on Drawings.
4. Spa Audible Alarm:
 - a. When the spa's emergency cutoff is activated, the Contractor must include provisions for a minimum 80-decibel audible alarm near the spa to sound continuous until deactivated when such a sound device is triggered.
 - b. The following additional rule sign must be installed to be visible by the spa, which reads "ALARM INDICATES SPA PUMPS OFF. DO NOT USE SPA WHEN ALARM SOUNDS UNTIL ADVISED OTHERWISE."

3.09 NOT USED

3.10 PUMPING SYSTEMS EXECUTION

A. GENERAL

1. Comply with the manufacturer's installation and according to the Hydraulics Institute's standards, commissioning, and start-up instructions and those with the Drawings and these Specifications.
 - a. Manufacturers for all pumps greater than 4 hp must provide written certification that the products were installed in complete conformance with their recommendations/requirements.
2. Install the specified hair/lint strainer upstream of each pump unless noted explicitly in the Drawings.
 - a. Exception: Not required for vacuum D.E. filter pumps.
3. All hardware must be 316L.
4. The contractor must furnish materials, equipment, and labor to furnish, install and test the pumping system complete with the pumps, integral hair & lint strainers, motors, piping valves, and accessories, as specified on plan drawings.
5. Allow a 12" minimum clearance behind the motor for servicing. Since motor overheating may be caused by a voltage drop or excessive voltage, the Contractor must confirm the wire size and voltage input are adequately regulated.
6. Pumps mounted above the water level must be manufacturer-rated as self-priming.
 - a. Self-priming tubing: Install a 0.25-inch [6.4 mm] diameter stainless steel tubing from each pump's suction side to the water discharge side of each Marlow self-priming pump with a check valve located immediately after the pump or to any self-priming pump with a motor larger than 3-hp. [1.49 kW].

7. Install pumps to meet the following:
 - a. Mount perfectly level.
 - b. Provide for significant equipment, reinforced concrete housekeeping bases/pads poured directly on structural floor slabs (or as required by equipment manufacturer) 6-inches thick minimum; unless noted otherwise on Drawings, extended 6-inches beyond machinery bedplates.
 - c. Provide templates, anchor bolts, vibration isolators, and accessories required for mounting and anchoring equipment.
 - d. Anchorage system must be per the equipment manufacturer's specifications and local code requirements. Consult with the equipment manufacturer for length and installation of anchor bolts.
 - 1) Grout equipment into place per the manufacturer's requirements unless required otherwise.
 - e. After the placement of a 90-degree elbow or another directional change fitting, a minimum of 5 pipe diameters of piping must be provided on the suction (upstream) side of the pump unless an upstream strainer is rated as a flow straightener is provided. Refer to the Equipment Schedule on the Drawings for the specified minimum requirements
 - f. The supply piping must be arranged/installed/mounted so that no airlocks can occur
 - g. Install eccentric reducers with the "flat" side facing upwards
 - h. Unauthorized deviations to the above may void the manufacturer's warranty.
8. Install rubber expansion joints on the upstream and downstream piping at each pump 5-hp or greater [3.73 kW].
 - a. Comply with manufacturers' requirements.
 - b. Align pumps with the attached piping before installing the expansion joints.
9. A designated manufacturer's representative must examine, approve, and validate the installation of Herborner, Marlow, Armstrong, and similar large pumps.
 - a. The certification must specifically address chemical feeder placement, proper pump alignment, the anchored supply piping, pump/motor lubrication, piping on the upstream side of the pump (with eccentric reducers), and VFD-rated electrical motor.
 - 1) Contact This Engineer for clarification if needed.
 - 2) Refer to the Contractor's certification section herein.

B. EQUIPMENT INSTALLATION

1. Install piping and equipment within the equipment room, as shown in the Drawings and as specified herein. All equipment must be in new and pristine condition.
2. Position and install equipment per the Details indicated in the Drawings.
3. Equipment must be provided per the Manufacturer's instructions & recommendations and the Contract Documents (to include the Drawings & Specifications).
4. Confirm dimensions based on actual equipment dimensions before the start of installation.
5. Unless noted otherwise by the flow meter manufacturer, position the flow meter (and sensor probes) to be per the manufacturer's requirements and as indicated below:

- a. Located in the upper quadrant of a horizontal-located pipe
- b. Installed according to manufacturer standards for +/- 5% accuracy:
 - 1) Installed with a minimum of 5 pipe diameters of clear, straight-pipe distance on the upstream side (no fittings, valves, or check valves must interfere with the required, stated clearances).
 - 2) Installed with a minimum of 2 pipe diameters of clear, straight-pipe distance on the flow meter's downstream side.
- c. Installed with the Type 7 minimum piping.
- d. Meters/sensors must be sized to accommodate 150% of the design flow rate.
6. Install NEMA 3R panel enclosures in equipment rooms unless otherwise noted in the Drawings.
7. Do not add chemicals to the piping system or collector/reservoir/surge tanks before the pumps, filters, or heaters (unless noted otherwise in the Drawings).
8. Label / I.D. equipment components as specified herein.

3.11 STRAINER ASSEMBLIES EXECUTION

A. CLEARANCES

1. Provide a minimum of 2 pipe diameters of connected piping size within 3-feet [0.9 M] of each strainer. Maintain this adjacent pipe clearance both upstream and downstream of each strainer.
2. Demonstrate that a full rotation of the adjacent valves closest to the strainer is possible and causes no hindrance to the strainer's routine disassembly, cleaning of strainer basket or screen, and viewing the interior portions of the strainer.

3.12 FILTER SYSTEMS EXECUTION

A. GENERAL

1. Only a single pump must provide the specified filtration flow into a single filter system unless authorized by The Drawings. The pool recirculation (filtration) system must be operated at all times (24 hours/day) except for maintenance purposes during which the pool must be closed, and use by bathers is not allowed.
 - a. Refer to the Drawings for the required turnover filtration rate of flow; however, observe the following minimum water turnover rates unless otherwise noted:

Type of pool/basin	Turnover hours
Swimming Pool	3
Spa	0.5
Wading Pool	1
IWF	0.5
Water Activity Pool (2-feet [610 mm] deep or less)	1
Water Activity Pool (over 2-feet [610 mm] deep)	2
Wave Pool	3

Slide Plunge Pool	2
Sun Shelf water space	1
Zero-Entry water space (0-ft to less than 3-feet)	2
Fountain / Water Feature (non-human use)	2

- b. Water features such as fountains or waterfalls in pools may use a maximum of 20% of the return water from the related filter system; however, all water flow rates used for the feature cannot be counted toward attaining the designed turnover rate. All such feature water must return that feature water to the same pool basin.
 - 1) Features spray nozzles, weirs, or waterfalls that require more than 20% of the filter flow rate must be supplied by an additional designated-pump that drafts from the designated collector tank. Refer to the Drawings.
 - c. The return piping system must be designed to handle the additional feature flow when the feature is turned off.
 2. Filters located within the collector tank:
 - a. Install the filters per the manufacturer's installation and operating manual.
 - b. Space the grids and elements per the manufacturer's requirements to prevent bridging between grids unless previously approved by the manufacturer.
 - c. The filter and vacuuming system must include the necessary valves and piping allowing filtering to pool, vacuuming to filter, vacuuming to waste, complete drainage of the filter tank, backwashing for sand, and pressure D.E.- type filters and precoat recirculation for D.E.-type filters.
 - d. Disposal of water from a pool using D.E. powder must be accomplished through the vacuum pump discharging via valved piping to both the filter tank and the separation tanks equipped with air-bleed valves and bottom drain lines, and isolation valves. D.E. separator tanks must have a rated-capacity by the manufacturer, equal to the filter system's square footage.
 3. Filter air compressor piping must be stainless steel piping, tubing, & fittings and must be securely affixed to adjacent surfaces.
 - a. Provide dielectric unions to prevent dissimilar metals from contact.
 - b. Secure the air compressor to Contractor-provided housekeeping pad
 4. All pools/spas must have a portable vacuum system or a permanent vacuum pump in the event of a vacuum-type filter.
 5. Ground/bond components & units, including the brass / stainless piping for the air compressor and similar components.
- B. TYPE 7 CLEAR PIPE PLACEMENTS
 1. Provide a minimum length of 2-feet [0.6 M] (or 3 pipe diameters – whichever is greater) of clear Type 7 pipe on the downstream side of the filter in the following locations:
 - a. Filter pre-coat pipe
 - b. Filter waste pipe
 - c. Downstream of the flow meter (within 3 pipe diameters of the meter).

3.13 TANK & CABINET EXECUTION

A. GENERAL

1. Unless noted otherwise, each tank must have signage indicating its contents and purpose.
2. No field-performed penetrations are allowed.
3. Install tanks per the manufacturer's instructions and the Engineering Drawings to prevent damaging hydrostatic uplift forces.
4. Locate and position all tanks strictly as indicated within the drawings unless This Engineer expressly provides written authorization to relocate.
5. No heavy equipment must be operated near below-grade tanks.
6. Observe the manufacturer's requirements during the installation.
7. All fiberglass floor surfaces in filter tanks must be installed to easily gravity-drain to a floor drain or manufacturer-provided grate and incorporate coved intersections between the wall and the floor.
8. Any fiberglass-type damage must only be corrected/repaired by the Manufacturer of the Tank/Cabinet assembly.

B. CHEMICAL STORAGE TANK EQUIPMENT

1. Installation

- a. Place the MSDS and a content label on each chemical storage tank. Encase the label within a waterproof, transparent container for protection.
- b. Vent each chemical tank to the atmosphere per the manufacturer's requirements. Extend ducting/vents to locations that must not expose chemical fumes to persons, materials, and equipment. The ventilation pipe must be a minimum of 1-inch larger in diameter than the most substantial pipe penetration.
- c. Tanks may be placed inside specific chemical cabinets or inaccessible areas as certified by the manufacturer.
- d. Securely-anchor buried chemical tanks against hydrostatic uplift pressures.
- e. CO2 low-pressure bulk tank and tank/fill/venting/monitoring accessories with related stainless-steel hardware must be provided and coordinated by the Contractor.

2. Field Testing

- a. After installation, the tank must be water tested. Fill the entire tank with water, monitor the tank and fitting connections for a minimum of 72 hours with no loss of water recorded.
 - 1) Exception: CO2 low-pressure bulk tank must be filled and charged with CO2
 - a) CO2 fill is to be provided by the Contractor
 - b) CO2 tank must be given/provided to the Owner in a full, filled status when the substantial completion is achieved.
- b. The contractor must correct leaks and re-test as above.
- c. The Contractor must empty all tanks after successful field testing.

C. COLLECTOR/RESERVOIR/SURGE TANK INSTALLATION & PERFORMANCE

1. General:

- a. Observe all manufacturer's installation instructions without exception.
- b. Observe the directions of the Geotechnical Consultant. Refer to This Engineer's Drawings for additional requirements. If a conflict occurs between the manufacturer's instructions, the geotechnical consultant's recommendations, and This Engineer's Drawings, issue a written inquiry for written clarifications before proceeding.
- c. Pre-Fabricated collector/reservoir/surge tanks:
 - 1) Testing Requirements at the Fabricator's / Manufacturer's Facility:
 - a) Demonstrate leak-proof integrity by performing a hydrostatic test with connections plugged or capped. Maintain water pressure for a continuous 24-hour period without leakage.
 - 1 The fabricator must attest/certify in writing the satisfactory performance and that any defects found were corrected before shipping the tank.
 - b) The tank manufacturer must provide a written certificate of successful waterproofing testing and written certification. The tanks are capable of withstanding seismic activity per the rated seismic zone for this project.
 - c) The tank manufacturer must provide written certification that the tank is sufficiently attached to the integral steel frame to prevent the tank's hydrostatic uplift flotation when the tank is empty but immersed/surrounded by adjacent groundwater.
 - d) The tank's Manufacturer must be on-site during the placement of the crushed stone and other backfill efforts.
 - 1 A written certification report from the tank's Manufacturer approving the tank placement and backfill procedures is required from the Contractor.
 - d. A minimum of 12-inches [305 mm] of well-drained, gravelly backfill material (#57 crushed stone) must be installed around the entire perimeter of the tank. A polypropylene geotextile filter fabric must be provided between the crushed stone and the earthen backfill to prevent soil infiltration into the crushed stone materials.
 - 1) Overlap the filter fabric a minimum of 24-inches [600 mm] and install per the manufacturer's requirements.
 - 2) Provide 12-inches [305 mm] sod staples as needed (per the manufacturer's requirements) to help prevent fabric movement.
 - e. Provide sock-covered perforated PVC slotted drainpipes to aid in preventing the accumulation of groundwater around the tank. Extend all drainpipes to the nearest storm sewer structure (or another noted outfall per the Drawings) in coordination with the project's civil engineer. Slope all drainpipes at a consistent downward slope at a minimum of 1% toward the storm outfall.
 - f. Fill the tank 25% full of potable water before commencing backfill. Place the filter fabric as a separation between the crushed stone and the backfill soils to match the water's elevation within the tank.
 - 1) Hand compact (with hand compaction equipment) all soils to a 95% optimum modified Proctor and secure written verification from the testing engineer. Refer to the backfill and compaction requirements with These Specifications.

- a) Caution: Mechanized backfill and large-equipment compaction are prohibited near the tanks to prevent potential collapse damage/peril.
 - b) Caution: No heavy equipment must be operated within 4-feet [1.22 m] of any tank's perimeter limits.
- 2) Continue filling the tank with an additional 25% of potable water and continue to match the backfill, as noted above.
- 3) Continue until the tank is filled with potable water and backfilled with the crushed stone liner and the filter fabric separating the stone and soils.
- g. A reinforced concrete ballast mass anchoring system is required on each collector/reservoir/surge tank. The reinforced tank foundation must extend 3-feet [0.91 m] beyond the exterior vertical tank walls.
 - 1) Refer any questions on collector/reservoir/surge tank installation to This Engineer before construction.
 - a) The addition of chemicals blended into the collector/reservoir/surge tanks is disallowed.
 - 2) Concrete Mass Anchors Written Certifications:
 - a) Provide written documentation certifying the concrete-mass-anchors provision at each collector/reservoir/surge tank. Comply with the drawings, confirm the dimensions in the certification, and include photos.
- h. Install overflow drains on each collector tank and discharge into an authorized outfall (via a 4-inches [100 mm] minimum air gap) or other outfall location per the Drawings. The Contractor must observe local environmental code requirements for water containing chlorine.
- i. Install a lockable enclosure on tanks located outside of the equipment enclosure or equipment mechanical space.
 - 1) Caution & Exception: Collector tanks must have a secured non-metallic grate safety platform installed (unless enclosed within a lockable cabinet).
- j. No modifications or alterations to the tank and its piping systems or installation directions must be made without the Engineer's express written authorization.
- k. Observe all manufacturer's instructions for installing, backfilling & compacting around and over the top, lifting, & setting pre-fabricated tank(s).
- l. Noted forced air ventilation, area sump pumps, gravity-flow supply pipes, suction piping, overflow drains, and the specified air-vent-to-atmosphere pipe must be connected and operating per the Contract Documents before commencing with backfill procedures.
- m. Tanks must be vented to the atmosphere without exception. If the air-venting is via an air pipe, extend the pipe's uppermost portion to be a minimum of 8-inches [200 mm] above the served basin's water level.
- n. The prevention of external pressures on the tanks' structure from vehicular traffic, mechanical backfill, and compaction activities around tanks is the Contractor's total responsibility.
- o. Connecting piping must be braced and supported before a permanent connection to the tank (not to create any external forces onto the tank).

- p. For reservoir & surge tanks: Before the decking being placed, the Contractor must verify that the piping systems are still holding a valid water-pressure test, as noted above. After the decking is placed, the Contractor may remove the water-pressure testing assembly per the tank manufacturer's requirements.
 - q. Label / I.D. collector tank components as specified herein.
 - r. Water discharged from fountains or features must flow by gravity via floor drain assembly(s) to a collection system that flows into the related collector tank.
 - s. The collector tank's minimum size must be equal to the volume of 3 minutes of the combined flow of all feature pumps and the filter pump. Smaller tanks may be utilized if hydraulically justified by the design engineer.
 - t. The Contractor must provide the operator's means of vacuuming and completely draining collector tank(s):
 - 1) Tank drain piping and related valving to direct water to an authorized waste outfall.
 - 2) Use of the portable vacuum system must be Contractor-provided to remove debris and water from the tank
2. In-ground tanks:
- a. Provide 1-cu yd. [0.8 m³] of ballast concrete (minimum) around the base of each fiberglass collector/reservoir/surge tank and below-grade chemical tanks per every 200 gallons [0.8 m³] capacity.
 - 1) Incorporate a thickened, reinforced, ballast floor slab with sufficient anchoring to the collector, below-grade chemical, reservoir, and surge tanks as needed to offset hydrostatic uplift loads.
 - b. Concrete tanks are designed to anticipate a groundwater level, as identified in the Geotechnical Report.
 - 1) Critical Caution: The contractor must confirm that the site drainage is sufficiently sloped away from the tank to prevent flooding or a moat-like effect occurring around the tank(s), which may increase hydrostatic uplift forces.
3. Install collector/reservoir/surge tanks in the locations and positions shown on the Drawings. The mandatory water supply pipes to the collector/surge/reservoir tank include perimeter overflow, skimmer, and floor drain pipes. Unless otherwise detailed, the tank elevation must be set to achieve a static (non-operating) water level at a dimension of no less than 6-inches [150 mm] (minimum) below the uppermost portion (referred to as the "Lip") of the collector/reservoir/surge tank.
- a. Collector tank: A tank that is open & vented to the atmosphere and has a static water level the same as the basin to which it is attached. The tank must be cleanable.
 - 1) Install non-metallic grate covering or other lockable, vented enclosure/hatch on each collector tank as scheduled.
 - 2) Mount each collector tank a minimum of 6-inches [150 mm] above the top of decking or coping immediately adjacent to the pool.

- 3) When collector tanks are used as filter tanks (containing D.E. elements or vacuum cartridge elements), the tank must be operated to prevent any of the D.E. Grids or Cartridge elements from becoming exposed to the atmosphere.
 - a) The drain pipe connecting the floor grate and sump to the filter tank must be capable of supplying 100% of the required filter flow rate to the tank at a drawdown level sufficiently above the top of the D.E. Grids or the Cartridge Elements).
 - b) The perimeter overflow piping connecting the perimeter overflow pipe system to the filter tank must be capable of supplying 100% of the required filter flow rate to the tank at a drawdown level sufficiently above the top of the D.E. Grids or the Cartridge Elements).
- b. Surge tank: A tank with a maintained water level that is lower than the basin's static level to which it serves. The surge tank must be vented to the atmosphere.
 - 1) Supply piping to the surge tank must slope toward the tank as denoted in the Drawings.
 - a) The absolute minimum pipe slope toward the tank must not be less than 2%; however, a higher slope may be stated in the Drawings
 - 2) Utilize open-channel flow calculations to determine the quantity and size of sloped supply pipes and their termination elevation above the tank's static water level.
 - 3) Surge tanks must have maintained lower water levels controlled by a field-installed, proportionally-controlled pneumatically actuated butterfly valve(s).
 - a) Field adjust the proportional control Main Drain Modulating Valve control and its related water level sensor with the 4-20 mA control board to achieve proportional valve operation and surge tank operations. .The use of a PID controller is mandatory
 - b) The installer must integrate the Main Drain Modulating Valve control operation to maintain an acceptable water level in the surge tank.
 - 4) Surge tanks located in below-grade equipment rooms must be equipped with a Normally-Closed (N.C. and fail-closed) pneumatic (air-operated) valve on each water supply pipe.
- c. Reservoir tank: an in-ground type of tank containing a minimum quantity of water filtered continuously and sanitized while being a water source for a grouping of nozzles, slides, wet play components, or water activity statuary. The reservoir tank may also be used as a collector tank for the filter system when sized appropriately. Access to the reservoir tank must be limited to authorized persons.
 - 1) Unless noted otherwise, the reservoir tank must have a minimum water capacity exceeding 3x the total flow (filtration + feature).
 - 2) Access wet decks must be provided for the reservoir such that all areas are accessible for vacuuming, skimming, and maintenance. The decks must provide a minimum width of 3-feet [914 mm] and a slope away from the reservoir.
4. Leak-test each tank (for documented waterproofing) as noted:
 - a. Concrete construction:

- 1) Utilize extreme caution to ensure that no exterior loads are placed upon the tank before the reinforced concrete achieves full strength and a minimum of 28 days after concrete placements.
- 2) Place the specified pipe Link-Seals (with Link-Seal Century Line sleeves) into the formwork before placing the reinforced structural concrete. Allow the concrete tank to cure a minimum of 28 days.
- 3) Apply Xypex Concentrate to interior tank surfaces. Observe and follow manufacturers' instructions & recommendations.
- 4) After curing the applied waterproofing, demonstrate the waterproofing adequacy by filling the tank with water and monitoring it for 72 hours with no loss of water recorded.
 - a) If leaks are discovered, drain the tank, correct the leaks, re-fill, then re-test as needed.

D. ABOVE-GRADE WATER TANKS

1. Installation
 - a. Tanks must be installed per the manufacturer's requirements.
 - b. No field penetrations are allowed.
2. Tank Inspection and Commissioning
 - a. Comply with AWWA D121-12 requirements.
 - b. Inform and train the operators of the routine maintenance procedures concerning the tank.
3. Leakage Test
 - a. Comply with AWWA D121-12 requirements.
 - b. Once assembled, the tank should be slowly filled with water. Adjust and tighten mechanical portions of the tank per the manufacturer's instructions.
 - c. If leaks are discovered, drain the tank, make corrections specified per the manufacturer's instructions & recommendations, and retest.

3.14 CONTROLS & INSTRUMENTATION – FLOW & PRESSURE EXECUTION

A. GENERAL

1. Install gauges, sensors, & switches per manufacturer's instructions to the drawings for specified gauge, sensor, & switch types.
2. Install unions and flanges as detailed to facilitate removal.

B. GAUGES & SENSORS

1. Refer to these specifications for the required identification tags for gauges.
2. Gauges, Meters, and Sensors:
 - a. Connect thermometer and flow meter electrical probes/terminals to the equipment mechanical space/chemical controller control panel.
 - b. Install the electronic sensors, digital instrumentation, and gauge mounts as detailed in the drawings.

C. INDUSTRIAL LIQUID FLOW SWITCH (OPTIONAL)

1. Observe the minimum and maximum flows as determined by the manufacturer.
2. Observe the upstream and downstream minimum clear pipe space requirements as set forth by the manufacturer
3. Coordinate with the electrical installer to verify that the switch has a minimum 2-minute safety operating period before activating the flow switch.

D. LIQUID LEVEL SENSOR

1. The sensor must be installed within a still pipe to mitigate possible wave action in the basin or tank.

3.15 CHEMICAL SYSTEMS EXECUTION

A. GENERAL

1. Equipment must be installed per the Manufacturer's instructions.
 - a. Manufacturers for each/all chemical/sanitation equipment must provide written certification that the products were installed in complete conformance with their recommendations/requirements.
 - b. All chemicals must be pumped into the pump's return line downstream, chiller, heater, and filters.
 - c. Critical: The use of chlorine gas is prohibited – there are no exceptions.
2. Label / I.D. chemical components, tubing, and hoses as specified herein.
 - a. Provide a minimum of 2 labels on each length of chemical tubing. Labels must state "CALCIUM HYPOCHLORITE," "CHLORINE," "SODIUM HYPOCHLORITE," "ACID," "MURIATIC ACID," or similar type wording.
3. The chlorine feeders must be capable of supplying a dosage of 6 ppm to the minimum required turnover flow rate (if solution type feeders, a 5% calcium hypochlorite or 10% sodium hypochlorite solution). Chlorine generators must be capable of operating at the "Full-Range."
 - a. Exception: For Slide pools, IWF's, Wave Pools, Water Play features, & Water Recreation Pools, the related disinfection equipment must be capable of feeding a minimum of 12 mg/L (ppm) of halogen to the pressure side of the continuous recirculation flow of the filtration system.
4. Coordinate additional chemical wiring and electrical work with Electrical Documents. Electrically-interlock the power supply to all chemical feed equipment with the recirculation (filtration) pump. However, the power to the chemical controller or sensor should not be interlocked this way.
 - a. The pool chemical system and filter system must be operated at all times (24 hours/day) except for maintenance purposes, during which the pool must be closed, and use by bathers is not allowed.
5. Install and position chemical equipment, CO2 feeders, chemical controllers, and sensing devices, including tubing, piping, and fittings, in the pool equipment packages or rooms, as indicated by the manufacturer(s), within the Drawings, and as specified.

- a. In the event of differences in the execution/installation requirements from the specific manufacturer and the requirements of The Engineer, contact This Engineer for written clarification.
 - b. Provide with required GFCI receptacles, junction boxes, probes, sensors, saddle connectors, electrical connectors and control relays, control logic, conduits/pipe sleeves, conductors, check-valves, and rate-of-flow indicators.
 - c. The following "chemical" sanitizers and controls do not emit corrosive fumes and may be placed in the main mechanical room or space.
 - 1) Ultraviolet (UV) sanitizers equipment
6. Provide chemical solution crocks marked to indicate contents. Locate and arrange as shown in Drawings
 - a. MSDS (within clear water-tight protector covers) must be affixed to each chemical container/crock.
 7. Provide chemical dilution and solution crocks with lids.
 - a. Do not puncture any chlorine, acid, or alkaline chemical crock lid.
 8. Chemical solution crock(s) must have a volume as indicated in the Drawings, but never less than 50% of the chlorine solution's maximum daily feed capacity and pH adjustment feeders.
 - a. When soda ash is used for pH adjustment, the maximum concentration of soda ash solution feed-rate must not exceed 1/2-pound (0.2 kg) soda ash per gallon of water.
 9. Locate/position the chemical equipment that emits corrosive fumes into a separate, designated room. Air to/from the chemical room must not be mixed nor blended with any other room.
 10. Provide the total ventilation/exhausting of air from within the chemical room an authorized code-compliant outfall to be a minimum of a 20x/hour or as certified/designed by the Project's Prime MEP / HVAC consultant
 11. No chemical feeders must "add/dump/mix" chemicals into a collector/reservoir/surge tank.
 - a. Chemical addition methods (upstream of the main equipment components) may void manufacturer warranties on specific devices. tapping
 - b. Chemical injections are directly into pressure piping via pipe saddles located after (downstream) of the primary equipment locations. The water flow must flow toward the basin or reservoir tank, as indicated on the Drawings.
 - 1) Note: Drilling and chemical tubes directly to piping materials are disallowed. Only chemical connections via pipe saddles are allowed.
 - 2) The minimum separation distance between Chlorine and Acid injection fittings must be 2-Ft [0.61 M].
 12. Chemical hose/tubing installation minimum requirements:
 - a. Examine the hose/tubing for any noticeable damage. If the hose/tubing is damaged, do not use it. Examples of damage may include slices of the cover, broken braid, and the hose's crushing (can reduce life and pressure rating).

- b. Accurately cut/trim the connecting hoses for each chemical feeder system so that no confusion or incorrect hose attachment to improper chemical equipment would occur.
 - 1) Critical: The use of Sulfuric Acid is prohibited
- c. Encase tubing transporting chemicals in a UV resistant, flexible chase or Type 1 piping with 90-degree sweeps. Tubing must be TYGON Chemical to accommodate 45-psi [3.1 bar] and vacuum rated to 29.9-inches [759 mm] of mercury; all @ 73-deg F. [22.7-deg C].
- d. Do not position hose/tubing over another container (having a different chemical stored).
- e. Do not allow severe bends nor twist (torque) assembly along the centerline during installation.
- f. The minimum separation distance between Chlorine and Acid injection fittings must be 2-Ft [0.61 M].
- g. The piping conduits/sleeves must be secured via wall-mounted supports, ceiling-mounted hangers, or floor-mounted supports in a professional manner acceptable to This Engineer's judgment.
- h. The spacing for the supports must be sufficient to prevent drooping, movement, & vibration while not exceeding the maximum separation distance noted for water pipes in these Specifications.

B. PULSAR PRECISION SANITIZATION SYSTEM

- 1. The Pulsar[®] Precision Sanitization System must be capable of satisfactory performance if installed as per the Manufacturer's recommendations (Reference Pulsar[®] Installation Manual).
 - a. An Authorized Representative of Pulsar (the Manufacturer) must be located within a reasonable distance of the pool location and must be available to install and service the system as required.

C. ULTRA-VIOLET (UV) SANITIZERS:

- 1. Only Type 2 PVC piping and fittings (or better) may be installed near the UV sanitizer.
- 2. Before commissioning and start-up, an authorized manufacturer's representative must validate the UV installation per the manufacturer's requirements and the Contract Documents.

D. SALINE CHLORINATION SYSTEMS

- 1. General:
 - a. Install the automated saline electronic monitor, controller, and related components per the manufacturer's instructions.
 - 1) Include all by-pass and isolation valving per the Drawings.
 - 2) The Contractor must pre-mount the system on an aluminum backboard.
 - b. All electronic connections to the generator and its control equipment must be electrically-interlocked with the filter pump's operation.

- 1) Manufacturer-supplied components must be wall-mounted, connected using the supplied power cables, supplied individually, and require field assembly.
- 2) Refer to the Manufacturer's instructions, installation recommendations, and operator-use documents.
- 3) The system must be bonded/grounded/earthed via the UL-Listed bonding/grounding lug to the local shared bonding grid.
2. Piping requirements
 - 1) Chlorine generator equipment is not suitable for subsequent water-pressure testing and must be valved to be off-line during subsequent water-pressure testing.
3. CHLOR SM specifics:
 - a. The basin and related piping must be certified to be leak-free before installing a saline chlorination system.
 - 1) The certification is mandatory for basins containing an elevated saline content necessary for the saline generator's operation.
4. NEX-GEN specifics:
 - a. The NEX-GEN plumbing of the production tank and accessories must be done at the time of the installation.
 - b. A pre-wired system, ready for field connection of power inter-connected to the pool pump and control circuits, is required. The plumbing of the cell must be done at the time of installation.
 - c. When using the ChlorKing® NEX-GEN, the basin salt-content may be zero (no saline required within the basins' water).
5. Chemical supply: The Contractor must provide the bulk salt to fill the salt tank for the commissioning and initial service period. Upon substantial completion, the Contractor must refill the salt tank to capacity.

3.16 HEATERS, HEAT PUMPS, & CHILLER SYSTEMS EXECUTION

A. GENERAL

1. The manufacturers for each chiller/heater/heat pump and the geothermal system must provide written certification to install all equipment per their recommendations and instructions.
2. Provide combustion air, exhaust gas-venting ducts, and fans (as specified) to the wall or roof locations as detailed in the Complete Build Scenario documents. Meet or exceed the heater/chiller manufacturer's requirements and local codes. Specific compliance with the heater/chiller manufacturer's requirements is mandatory.
3. Install vent lines, barometric damper devices, and condensate piping/tubing to the authorized waste outfall per applicable codes and directed by the manufacturer. Provide and finalize "below-grade" gas hookups per local codes and regulations.
4. As a minimum, the design intent requires Category I negative draft, noncondensing, and include only Vent Type B galvanized steel, double-wall vent, ducts, flues, and piping.
 - a. Provide a Tee and Barometric exhaust relief damper per the manufacturer's requirements.

- b. Observe minimum slope requirements with a rise of 0.25 inches per foot for near-horizontal ducting.
- 5. For Category “III, IV” configuration (not utilizing a fan at the point of termination), the ducting must be stainless positive pressure vent material and used with associated vent kit accessories per the manufacturer.
 - a. Provide a Condensate Tee installed in the venting system with a tubing draining to the nearest floor drain – per the Manufacturer’s requirements.
- 6. Provide high-temperature relief metallic piping from the pressure relief valve discharging toward the floor/ground. Terminate relief valve pipe to within 6-inches [150 mm] of the floor/ground.
- 7. Provide pipe sinks, gauges, thermostat devices, flow-switches, and thermometers to comply with the appropriate boiler codes and achieve proper controls.
- 8. Label/I.D. chiller/heater components as specified herein.
- 9. Provide flow arrows on piping connections and pipe supply to each unit.
- 10. The maximum piping equivalent distance allowed between the pool main return line and the heater face is 15-feet [4.5M]. The equivalent piping distance definition requires the sum of the equivalent distance (in feet) for each fitting + the actual pipe length between fittings.
 - a. The Contractor’s installation, contrary to the Contract Documents and the manufacturer’s recommendations resulting in an equivalence distance exceeding a 15-foot dynamic head, must require that the Contractor provide an additional booster pump with related electrical components at his sole costs & expense.
 - b. The Contractor must precisely observe and follow the following in order of importance:
 - 1) Local codes,
 - 2) Manufacturer’s piping requirements, piping distances, Type 3 piping, and valves (CPVC valves when piping water velocity is less than 5 FPS and metallic valves when water velocity exceeds 5 FPS)
 - 3) Contact This Engineer if there is a conflict between local codes and the Manufacturer’s requirements.
- 11. Do not add chemicals to the piping system upstream of the heater.
- 12. Maintain manufacturer’s requirements for minimum clearances around heaters, heat pumps, and heat exchangers. Provide access to the front header of the heat exchanger for routine inspections, cleaning, and repair. Place heaters on sloped & self-draining concrete pads and provide all drainage equipment to prevent standing or puddling water.
- 13. Hydro-test the unit to a minimum of 1.3 times the design pressure and as directed by the ASME Code.
- 14. Gas pressure status: Refer to SUBMITTALS to include written verification of the verified, tested on-site gas pressure.
- 15. Heaters nor chillers must not prevent the attainment of the required turnover rate.
- 16. Basis of Design: Refer to the Designated Specialty Engineer’s documents and all manufacturer’s instructions & recommendations without exception.
 - a. These are Complete Build activities. Refer to COMPLETE BUILD SCENARIO OVERVIEW

B. HEATERS AND PLATE HEAT EXCHANGER INSTALL

1. Install factory-supplied gas heater mounting racks, venting, ducting, flues, and barometric dampers required for compliance with the manufacturer's requirements and codes.
2. Supply instructions for the proper setup and operation of by-pass valves with the heater.
3. Heat exchanger units must be certified to be ASME rated.
4. Dissimilar materials must be isolated via the use of an appropriate dielectric connector.

3.17 ELECTRICAL POWER & ELECTRICAL CONTROLS EXECUTION

A. GENERAL

1. Refer to the Designated Specialty Electrical Engineer's Documents.
2. The Contractor must provide in compliance with Division 26 Electrical, and the electrical equipment wiring, installation (including the bonding & grounding of pool components) as per the manufacturer's requirements, and with the local Building Code
3. All components, assemblies, and enclosures must be provided by a UL-listed fabricator. Each fabricator shop must include & provide each assembly and each enclosure permanently-mounted UL-listing registration codes and ID numbers.
4. Maintain a 48-inches [1.22 m] minimum, unobstructed clearance in front of each panel, motor starter, control panel, underwater lighting, automation panel, VFD, power supply, transformers, and other NEC & IEC required disconnects and switch boxes.
5. Underwater lighting conduits are a familiar source of water leaks in a pool. The conduits serving underwater lights are designed to fill with chlorinated pool water, but water should not leak from them to the surrounding areas.
 - a. After an initial fill of the pool, but before startup of equipment, visually inspect exposed conduits, including fittings, serving underwater lights for potential water leaks. Repair as needed, then re-test.

B. COMPLETE BUILD SCENARIO

1. Refer to the Electrical Engineer's Documents. The Contractor must provide all required items/tasks in this section in addition to the requirements of the Electrical Engineer
2. Install the panels, control systems, control panel systems, lighting control systems, power wiring, circuit breakers, connectors, disconnects, rigid & flexible conduits, and control wiring features necessary for the operation of equipment specified in the drawings as a complete build scenario. Consult all manufacturer's installation guides and refer to the Electrical Engineer for inquiries. Conduits must each comply with the NEC-required minimum vacant space without exception.
3. Install electrical/control wiring & control panels, including components, connectors, equipment, and materials for entirely operational systems in full coordination with the selected fountain/water feature/timing controls' manufacturers and distributors to certify complete compatibility with the logic and peculiarities for such components, electrical interlocks, automated operations, and suitable programmability.

4. As a minimum Contractor requirement, each circuits' load (and their respective power supplies) must be adjusted/balanced to match adjacent circuits' loads with a maximum 5% deviation between circuits. The Contractor must correct/modify connections/wiring terminations as needed to comply/deliver the mandatory, balanced load requirement on each circuit and power supply.
5. The electrical interlock must be provided to deactivate chemical feed systems when there is no water flow in the recirculation system.
 - a. Provide Solid State Industrial Ground Fault Circuit Interrupting Relays for each basin-located submersible pump assembly.
 - 1) Mount each Industrial GFCI unit within the Control Panel System.
6. Install earthing, grounding, and bonding for each metallic component as required by the NEC, and State & Local Codes, with products and materials certified for such purpose and per the manufacturer(s). The successful operations of the grounding, earthing, & bonding systems must be the responsibility of the Contractor as a Complete Build Scenario.
7. Control System Overview:
 - a. Due to the submersible nature of the system, all submerged equipment has to be rated IP68.
8. Control System Narrative
 - a. An integrated control system (serving submersible components) is required. Each water effect is supplied with AC power and show data to control each of the assemblies. Show control data is distributed via DMX-512. That information is then parsed into the signals, which control each assembly's discrete elements (controllable valve, lighting).
 - b. The major components of the system are:
 - 1) Power Distribution
 - 2) Main Show Controller
 - 3) Data Network
 - 4) Submersible Controllers
 - 5) Submersible Controllable Valves
 - 6) Submersible LED Lighting
 - c. All components are connected via submersible cables and connectors. All conductors are non-corrosive. Each component can easily be connected and disconnected for ease of installation and maintenance.
 - d. Each water effect nozzle can be individually controlled for:
 - 1) Nozzle On/Off
 - 2) Nozzle Effect Height
 - 3) Nozzle Velocity
 - 4) Led Lighting Color (RGBW)
 - 5) Led Intensity
9. Lighting Effects Narrative
 - a. The water effects are illuminated using integral led lighting fixtures. The LED light is the latest generation of LED luminaires.

- b. The fixture surrounds the nozzle with brilliant Red, Blue, Green, and White (RGBW) LEDs. The fixture must be selected for its brightness and color. The LED technology allows for the most efficient output of light.

10. Safety Precautions and Hazards Narrative

- a. The specified equipment does not include any batteries or compressed fluid, or other forms of energy storage.
- b. Disconnect power to the equipment installed in the basin before approaching to perform maintenance work in the moat.
- c. Observe lock-out, tag-out procedures as the first and last step of any maintenance operation to ensure that no other person could re-connect the power while maintenance work is underway.

11. Programming of the Control Panel and its PLC's for each pool served by the Control Panel

- a. Screen Displays to include & show:
 - 1) Operational status of each pump with an on-screen method to manually deactivate each pump – or – have each pump remain in auto mode to operate per the time clock function
 - 2) Pool(s) Filtration System operations
 - a) Each Filter pump's flow GPM rate, as reported by the flow sensor, must be displayed on the screen
 - b) The Filter Pump's VFD rotational speed is controlled via the flow sensor's signal to the filter pump's VFD to enable the related pump to achieve the prescribed water flow (GPM) based upon the flow sensor(s) report (an increase in rotational speed or – a decrease in rotational speed).
 - 3) Feature pump's flow:
 - a) The Operator must have the on-screen option to initially adjust each feature pump's VFD to operate at the Hz that provides the operator's target flow rate.
 - b) After the operator's Hz initial selection for each feature pump, then the time clock settings (by the operator) controls the operating hours of each feature pump
 - c) The Screen must allow the operator to select Manual / Auto / Off (HOA) for each feature pump
 - 4) Each Feature Pump's time clock programmability for each feature pump must be a Screen Display allowing the operator's choices/selections.
 - 5) Operation of the "Trash Pump" – either "ON" or "OFF" as selected on screen by the operator
 - 6) The screen must allow the manual deactivation of each pump – or – each pump may be left in the Auto Mode
 - a) which is 24/7 for each Filter Pump – or –
 - b) which is the hours of operation desired for each Feature Pump
 - 7) Chemical System – Acid Tank Level
 - a) The level sensor in the acid tank transmits an alarm when the quantity of the diluted acid content is at 10-gallons and then,

- b) deactivate the Filter pump when the quantity of the diluted acid contents is less than 5 gallons.
- 8) Electrical interlock between the Filtration Pump(s) and the Chemical System
 - a) The deactivation of the filter pump must cease the operation of all related chemical systems via the electrical interlock.
- 9) Pool Underwater Lights – their programable timer, and again – auto mode or manual mode or off. Note there is a photo-cell installed to prevent the underwater lights from operating when it is daylight
- b. Screen displays must indicate when a VFD Fault occurs
 - 1) Each VFD-equipped pump must have a VFD fault indicated when a VFD fault occurs
 - 2) An alarm must be provided for each pump's VFD Fault
- 12. The Contractor-selected panel fabricator must certify control & power panels' installation/execution as installed compliant with the manufacturer's requirements and compliant with the related UL listing on the panel(s).
 - a. The Contractor's Delegated Electrical Engineer must certify that the control panels and all electrical work were completed per the NEC and local codes.

C. BONDING, EARTHING, AND GROUNDING INSTALLATION

- 1. Refer to the Designated Specialty Electrical Engineer's Documents.
- 2. Install the bonding, earthing, and grounding of electrical components (including light rings) located within the basins before any concrete work. Include equipotential bonding for all metallic components per NEC 680.26 to provide compliance and these requirements. A bonded concrete pool basin structure must be considered to be a conductive surface.
- 3. Electrically bond, earth, and ground each metallic device within and around the pool basin's perimeter (in soil/earth) with a #8 solid, bare copper ground wire per the NEC requirements and local codes). Secure required conductor under the perimeter surface 4 to 6-inches [100 mm to 150 mm] below the subgrade.
 - a. At least one minimum 8-AWG bare solid copper conductor must be installed (for bonding/grounding conductors in earthen soil). Connections to bonded parts must be made per Section 250.8 of NFPA 70, National Electrical Code.
 - b. Critical: No exceptions are permissible without the written approval of this Engineer or that of the Designated Specialty Electrical Engineer.
 - 1) Exception: Grounding/bond/earthing conductors immersed in water must be coated/insulated (with an insulation-listed immersion rating as water-proof). The color of the grounding/bond/earthing insulation must be green. All exposed copper & UL-Listed bonding/grounding lug attachments must have the specified UL-Listed potting compound installed.
 - 2) Exception: If the body of water is not intended for use by people, the bonding/grounding conductor size may be reduced according to Table 250.122 appearing in the NEC.

4. Apply the UL-Listed potting kit at each UL-Listed bonding/grounding lug, connections to the primary grounding electrode system, equipment attachment, and rebar juncture. Each bond/ground conductors' connections must be UL-Listed-type or exothermic weld in compliance with NEC.
 - a. The material Potting Compound must be packaged in the two-part plastic composite closed mixing pouch. The resin must be mixed within the closed-mixing pouch by separating the barrier between the two parts of the contents bag and working the internal materials back and forth within the bag.
 - b. Exceptional workmanship is required to prevent the spilling of the potting materials onto adjacent surfaces. If potting materials are spilled, the Contractor must thoroughly remove it and correct all contamination/damage.
 - c. Exception: Grounding/bond/earthing conductors that are immersed in water must be coated/insulated. The insulation for grounding/bond/earthing must be the color green (with an insulation-listed immersion rating as water-proof). All exposed copper must have the specified UL Listed potting compound installed. The potting compound must cover/protect bare copper conductors and the noted UL-Listed ground lug(s) without exception.
5. Grounding Loop: Install one #8 solid, bare copper ground wire continuously around the exterior of the pool basin and associated structures between 18 – 24-inches [455 – 610 mm] beyond the perimeter of the pool and building slab edge, buried 4 – 6-inches [100 – 150 mm] below grade. Include bonding, earthing, and grounding connectors with the central grid, and verify total continuity.
 - a. The conductors and ground loop (on the exterior of the basin) must follow the contour of the pool basin's perimeter surface and the building (or slab-on-grade).
6. Attach bonding/earthing/grounding connections to the pool's structural reinforcing steel to a minimum of four (4) points uniformly spaced around the pool basin's exterior perimeter.
7. Install grounding/earthing/bonding jumpers (or lugs) to rebar and lights, hydrants, deck anchors, handrails, ladders, ADA lift units, nozzles, competitive equipment, sports, and other similar metallic components within the basins. Without exception, extend the ground/earthing/bonding loop connection to the adjacent building's central grounding electrode system.
 - a. Critical: Neutral conductors must not be substituted for grounding/earthing/bonding conductors.
8. Install grounding/earthing/bonding jumpers (or UL-Listed lugs) to rebars for adjacent deck showers, deck receptacles, and other metallic equipment within 15-feet [4.57 m] of the pool's water edge.
9. Extend the ground/earthing/bonding loop connection to the pump, filter, metallic components/piping within the mechanical room, heater, shower, and chemical equipment at each basin. Verify grounding/earthing/bonding wire conductors are securely fastened to the adjacent piping, structure, and equipment.
10. For pools with non-conductive reinforcing steel, refer to the ADE Drawings for additional requirements.

11. Once all basin-perimeter metallic equipment is installed, the installer must perform bonding/earthing/grounding continuity tests/verifications via the use of audible sounding/bell ringing devices or other pre-approved equipment.
 - a. Achieve a satisfactory "sounding" continuity verification between each metallic equipment item at the basin's deck edge perimeter
 - b. Achieve a successful "audible-sounding" continuity verification between each metallic equipment (at the basin's deck edge perimeter) and the mechanical room's metallic equipment.
 - c. Once all the "sounding" is completed and successful, an observation from This Engineer is required.
 - d. The Contractor must pay for the manufacturers' representatives to observe and certify the proper installation of the underwater lights, splicing connectors, push-connectors, junction boxes, the potting kits, all per the manufacturers' requirements and recommendations without exception. Provide all written certifications to This Engineer.
 - 1) Each manufacturer must provide a written certification confirming the successful installation procedures were achieved without exception.

D. ELECTRICAL EXECUTION/INSTALLATION

1. Refer to the Electrical Engineer's Documents.
2. Install the main power supply to each load center. Supply 120 vac power to the underwater LED light low-voltage power supplies/transformers (located around its perimeter). Confirm the available voltage and electrical supply with the electrical engineer before connecting the equipment.
3. Install the control panel and lighting panel systems (with related componentry) per the NEC. Refer to the Specialty Designated Electrical Engineer for Drawings, schedules, and inquiries.
 - a. The control panel must include all necessary controls, including the Industrial GFCI for each basin-located submersible pump assembly.
 - b. Each control panel and lighting panel must be installed so that the bottom of the enclosure is a minimum of 8-inches [200 mm] above the highest possible water level within the water basin it serves.
 - c. No conduits from the basin must enter the enclosure except through the enclosure's bottom-most portions.
 - d. Provide UL-Listed sealants at each conduit/enclosure juncture to prevent moisture and corrosive fumes from entering the enclosure.
 - e. Wire-Nut type connectors are disallowed; utilize only Wago Splice-Connectors without exception.
4. Conduits must be rigid Type 1 (or better) placed a minimum of 18-inches [455 mm] below grade. Coordinate the following with Specialty Designated Electrical Engineer:
 - a. Conduit size providing power to the various subpanels
 - b. Conductors' quantity and sizes
 - c. Maximum/rated circuit breaker panel loads
 - d. Connectivity and full operations from all control panels and lighting control panels.

5. Unless noted otherwise or required by the equipment manufacturer, bonding/earthing/ground wires are not to be placed within conduits
 6. Refer to these specifications and the Electrical Engineer for mounting material requirements and further installation procedures.
 7. Pools/basins for swimming or human use:
 - a. No overhead wiring must be placed within 10-feet [3.05 m] horizontal of the pool wall's inside edge.
 - 1) Install one GFCI-protected receptacle located a minimum of 10-feet [3.05 m] and a maximum of 20-feet [6.1 m] from each pool water's edge (applies to pools, wading pools, outdoor spas, and interactive water features). Coordinate GFCI receptacle locations with the architectural and landscape architectural drawings.
 - a) Exception 1: In the event of an indoor spa, the GFCI-protected receptacle must be located a minimum of 5-feet [1.52 m] and a maximum of 10-feet [3.05 m] from each spa water's edge.
 - b) Exception 2: Such receptacles are not required for non-swimming water features/fountains/lakes.
 - 2) Electrical junction boxes must be located at a minimum of 4-feet from the pool basin walls.
 - b. Wet Niche Lights: Provide niche-mounted underwater lights with 4-feet [1.22 m] of excess electrical cord (stored in the light's wet niche). The excess cord allows the light fixture to be relocated for routine servicing.
 8. Spas or heated pools with therapy pumps:
 - a. The Contractor must install electrical work (GFCI's, power supplies/transformers, timer switches, clock (visible from the spa), emergency cut-off switches, and grounding systems. The therapy pump timer switch must only operate the therapy pump for a maximum of 15 minutes.
 9. Filtration pumps for basins and feature pumps for slides or wet-play (and similar equipment) must be equipped with an emergency safety cut-off switch.
 - a. Install the emergency safety cut-off switch to deactivate all pumps (including filtration, feature, and therapy pumps), including relays, bather-operated safety switch, and a related 80-decibel alarm into a NEMA 3R enclosure (or higher).
 - 1) When the emergency safety cut-off switch is depressed, pumps are to be deactivated. The alarm sound and flash continuously until an authorized person re-activates the cut-off safety system.
- E. MOTOR STARTERS AND VFD's
1. Refer to the Designated Specialty Electrical Engineer's Documents.
 2. Comply with motor starter and VFD manufacturers' installation requirements.
 3. Ensure that the VFD can detect and react to changes in back pressure to maintain a steady flow
 - a. Provide the VFD with a flow sensor, pressure transducer, PID loop programming, and similar equipment
 4. Ensure that the VFD can detect and react to a no-flow condition

- a. Provide a demonstration of the VFD's programming by closing valves to create a no-flow condition during the commissioning process. The Contractor must provide a flow sensor with related controls and connections. The contractor and his Delegated Electrical Engineer must consult the VFD manufacturer's manual and programming guide.

F. CIRCUIT BREAKER PANELBOARDS, JUNCTION BOXES, & CONDUITS

1. Refer to the Electrical Engineer's Documents.
2. Refer to the wiring schematics for associated circuitry with Circuit Breaker Panelboards (CBP) and branch circuits shown in each panelboard schedule.
3. Identify the voltage/phase and is 60-Hz [50 Hz] on each panel's front surface.
4. Size phase, neutral, and ground wires for the 100% amperage shown. Size conduits for the complete wire bundle consisting of 3 conductors. When multiple conductors or wire bundles are placed within the same conduit, increase the conduits' quantity & size to comply with minimum allowable space requirements per NEC, Chapter 9, and Table 3C.
 - a. If the illustrated or drawn conduits and junction boxes, when filled with conductors, do not provide the NEC-required minimum open space, the Contractor must submit an RFI and a proposed solution by providing additional conduits (or increasing the conduits sizes) and junction boxes.
 - 1) The junction boxes' quantity and sizes must anticipate that Wago slice connectors and terminations are incorporated.
 - 2) Such an event must be resolved by the Contractor providing the additional conduits at no cost to the Owner/Client
 - b. The Contractor must not proceed until The Engineer has provided a written response.
5. Amperage ratings indicated on the Circuit Breaker Panel (CBP) schedule are for each circuit breaker. Size conductors for 100% of the amp rating for the overcurrent circuit breaker unless other secondary protection is specified.
6. The CBP schedule indicates the 100% -Load Amperage (FLA) rating on each circuit. Wiring and conduits must be sized for the 100% circuit breaker rating for each branch circuit.
7. The CBP schedule identifies the (FLA) on each leg of a 3-phase circuit. On 1-phase circuits, the branch circuit must be connected to the phase leg shown to balance the Phase loading within 10 percent.

3.18 NOT USED

3.19 NOT USED

3.20 VALVING SYSTEMS EXECUTION

A. VALVES

1. Install valves per the manufacturer's instructions to the drawings for specified valve types. Install unions and flanges as detailed to facilitate removal.
2. Refer to these Specifications for the required identification tags for valves.
3. Install butterfly valves on each side of each pump and as detailed in the Drawings.

4. Return piping, floor drain piping, and surface overflow system piping must each have proportioning valves.
5. Check Valves:
 - a. Check valves must be installed per the manufacturer's instructions & recommendations.
 - 1) Check valves may be installed in horizontal lines with the disk hinge pin in the vertical position or vertical lines with the flow "up."
 - 2) Do not install check valves on vertical pipes with downward water flow.
 - b. Install 5 pipe diameters of clear pipe space upstream and downstream of each check valve. Flow straighteners may be fitted in place of explicit pipe space. The designation of "flow straightener" must be determined and identified by the manufacturer of that component.

3.21 NOT USED

3.22 NOT USED

3.23 MAINTENANCE & PRE-COMMISSIONING EXECUTION

A. GENERAL IDENTIFICATION REQUIREMENTS

1. Each major item of equipment must be identified by stenciled marking, which must read the same as the identification shown in Mechanical or Electrical Drawings.
2. The contractor-provided stencil letters must be uppercase (capital), not less than 1-inch [25 mm] high, and painted with white or contrasting color Effecto Enamel.
3. The contractor-provided labeling of the chemical containers and crocks must include a minimum 2-inches [50 mm] large lettering indicating each tank's stored chemicals. Use "Black text" on "Orange background" colors. Additionally, place warning labels (minimum 1-inch [25 mm] high lettering) instructing the proper chemical dilution methods authorized for these systems.
4. I.D. tags and labels: Use the following colors guide for labels and tags except for chemical/corrosive piping and valves:
- 5.

Basin Name (use the actual name of the basin)	Valve Tag & Label Color Assignment
1	White text on Green tags/labels
2	Black text on White tags/labels
3	White text on Gray tags/labels
4	White text on Black tags/labels
5	Medium Blue

B. PIPING AND VALVE IDENTIFICATION

1. Prominent color bands in the form of pressure-sensitive tape must be placed on each pipeline-type.

- a. Prominent color bands must be 3-inches [75 mm] in width, placed at a minimum of 10-feet [3.05 m] intervals, and the pipe runs, immediately preceding the line's passage through a wall, ceiling, and floor, and at each equipment connection or line valve. The following piping ID colors must be utilized:

Piping Name / Purpose	Identification Color Assignment
Suction/Gravity Drain	Green
Filtered water	Light Blue
Waste/backwash	Brown
Heated	Yellow
Chilled	Medium Blue
Chemical/Corrosive Liquids	Orange

- b. Adjacent to each color band, an abbreviation of the name/purpose (as listed immediately above) of the pipe/valve function must be placed.
- 1) Letters must be 0.5-inch [13 mm] high upper-case, applied with pressure-sensitive tape.
 2. I.D. Tags specified on valves (to match the Valve ID chart).
 3. Upon accomplishment of the Work, the Contractor must provide one (1) copy of each laminated valve chart 18-inch x 24-inch [455mm x 610mm] sealed to the rigid backboard, placed under glass, and framed, and must be hung by the Contractor in a prominent location in the equipment room.

C. PRE-COMMISSIONING

1. Before the commissioning events, provide, test, and confirm that control wiring connections communicate.
 - a. Includes but not limited to:
 - 1) filtration system controls
 - 2) pump controls & emergency safety cut-off system with relays
 - 3) VFD operations
 - 4) chemical controller operations
 - 5) flow metering, level sensing/controls, wind controls, and pressure operations
 - 6) saline chlorination system operations
 - 7) UV sterilizer unit and controls operations
 2. Provide the following for each pools' mechanical equipment spaces:
 - a. Mount valve identification charts, guides, and the equipment' operating instructions in laminated protective sleeves are set in a stainless steel or PVC frame.
 - b. The Contractor must provide a completed installation of ID labels, placards, ID bands on each component (i.e., valves, check valves, pumps, filters, strainers, and chemical components).

3. Chemical system operations to be completed

D. ROUTINE CARE AND CLEANING

1. Routinely wipe down the surface finishes of each significant component within the equipment room.
2. Maintain surfaces finishes being pristine, easily maintainable, free of dirt, dust, and other miscellaneous debris.
3. Care of Stainless Steel:
 - a. Weekly lightly polish the exposed stainless-steel surfaces with a mild coating of clear Mineral Oil (or similar product) to maintain these finishes and surfaces in a pristine condition.
 - b. To remove light scratches from the stainless steel, hand-buff the stainless with flour to scour the surfaces lightly. Eliminate the flour with a damp cloth and then a dry cloth. Finally, then apply the oil mentioned above.
 - c. The Basis of Design: Johnson's Baby Oil, high-grade olive oil, or similar equivalent products.

3.24 NOT USED

3.25 NOT USED

3.26 NOT USED

3.27 NOT USED

3.28 NOT USED

3.29 MISCELLANEOUS EXECUTION ACTIVITIES

A. INDIRECT VACUUM ASSEMBLY WITH VACUUM PUMP

1. Refer to the Drawings for installation details.

B. DECK SHOWERS / WATER SUPPLY / WASTEWATER INSTALLATION

1. Deck shower(s): Refer to the Architect or the Landscape Architect's drawings for the deck shower design and location.
2. Hose bibb(s) must be provided to facilitate the deck areas' water-flushing and installed with anti-siphon devices (vacuum breaker) without exception.
3. The pool makeup water supply is from an approved potable water system or meets those requirements with bacteriological/chemical reports to the local government health department. Provide both auto-fill and manual fill valves on each water-fill system. Provide a minimum 4-inches [100 mm] air gap below the water-fill system's terminus.
4. Provide backflow preventer and water hammer/shock arrestor devices located within the piping diagram and per their manufacturers' instructions.
5. Provide the backwash sump and related water waste pipes to transport the pool filter backwash outfall, deck shower assembly water, and deck drainage water to their authorized outfalls to the sanitary sewer as detailed (maintain a minimum 1.5% slope for each gravity flow waste pipe).

- a. A minimum 4-inches [100 mm] air gap is specified for each filter backwash and pool overflow pipe draining into the sump (or similar waste outfall) unless noted otherwise. The backwash waste pipe's elevation must be a minimum of 24-inches [610 mm] above the Finish Floor.
 - b. A Contractor-provided waterproof reinforced concrete backwash sump must include waterproofing with Xypex Concentrate or an approved equal.
 - c. Extend backwash sump and equipment room waste piping to the sanitary sewer in compliance with local codes. Size waste-water line to accommodate the specific filter/backwash 100% flows in a gravity-flow condition.
 - d. Pool overflow (commonly caused by rain events) must be piped to the authorized outfall, utilizing a minimum 4-inch [100 mm] air gap, per local environmental requirements.
6. Non-metallic tubing and piping exposed to sunlight and UV rays must be protected with UV inhibitors or ultraviolet-resistant coating (for piping & fittings only) as required on the drawings.
 7. Install scheduled Type 1 piping reducer bushing to act as a funnel. Provide a separate overflow and waste line from each pool (in the event of multiple pools).
 8. Install the various potable water fill connections and fittings within equipment room enclosures and at the various deck locations, as indicated on the drawings.
 - a. Protect fill systems with Contractor-provided water hammer arrestors and backflow preventers as specified and detailed.

C. WATER LEVEL CONTROL SYSTEMS

1. Provide water level control systems as specified in 2.16, Manufacturer's Instructions, and as follows.
 - a. Route 2-inches [50 mm] static lines from the pool basin into the specified Mechanical Areas (collector tanks mounted level with the basin water level). Caution: This static pipe(s) must continually slope toward the level sensor at a 2% minimum to prevent air-locks. Only eccentric reducers (flat side up) are allowed on the static piping.
 - b. Install potable water service in the Mechanical Equipment Room or Area as specified. Fit with isolation valve and backflow preventer.
 - c. Install a potable water supply manifold to each static line location.
 - 1) Provide valving for manual and automated fill operations as detailed.
 - d. Adjust the water level control device only after water flow adjustments to subsystems have been completed.
 - e. The Contractor must label/I.D. water-fill components as specified herein.

D. PERMANENT RAILING SYSTEM FOR ELEVATED PLATFORM FALL PROTECTION

1. Examination
 - a. Do not commence installation until the substrates have been completed.
 - b. Notify This Engineer and Architect if the substrates are not prepared satisfactorily.
2. Installation
 - a. Install per the Manufacturer's recommendations
3. Protection

- a. Protect installed products until completion of the project.
- b. Touch-up, repair, or replace damaged products before Substantial Completion.

E. FLOOR ACCESS DOORS:

1. Examination

- a. Examine substrates & openings for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only-after unsatisfactory-conditions have been corrected and approved by the Manufacturer's Representative.

2. Installation

- a. Install materials/products in strict accordance with manufacturer's instructions and approved submittals. Locate units to be level, plumb, and in proper alignment with adjacent work.
 - 1) Test units for proper functionality and adjust until the proper operation is achieved.
 - 2) Extend drain piping to the storm sewer per the Drawings. Slope piping away from the access door at a minimum of 2%.
 - a) Critical: The water discharge from the hatch drain piping into the vault is disallowed.
 - 3) Repair finishes damaged during installation.
 - 4) Restore finishes, so no evidence remains of remedial work.

3. Adjusting & Cleaning

- a. Clean exposed surfaces using authorized-methods acceptable to the manufacturer, which must not damage the finish.

F. COMPRESSED AIR SYSTEMS

1. General:

- a. The installer must adhere, follow, and observe the manufacturer's guidelines, instructions, recommendations, and requirements.
- b. The compressors' operation must be controlled via pressure sensors to activate the compressor system when the air pressure falls to a minimum sensed pressure and then operate to increase the air pressure within the receiver tank system until the air pressure reaches the pre-determined "high" pressure.

2. These activities are a "Complete Build Scenario" for the Contractor.

3. Upon completion, the Contractor's Specialty Engineer must provide a written certification ensuring proper installation and design.

3.30 NOZZLE SYSTEMS EXECUTION

A. GENERAL:

- 1. Nozzle performance: The manufacturer must provide written certification that the nozzle assemblies (nozzles in conjunction with the related fountain piping systems) deliver the manufacturer's design intent relating to the intended spray effects.

B. CLEAN PIPING & FLUSH SYSTEM BEFORE NOZZLE CONNECTION

1. The Contractor must clean the pipe interior of debris, foreign matter, and sand; maintain the pipes to be clean during installation.
 - a. Flush the pipes sufficiently so that no foreign debris may encounter the nozzle assemblies.
 - b. Pipes must not be exposed & placed in standing water, mud, or when the trenches or weather conditions are unsuitable.

C. STAINLESS STEEL COMPONENTS

1. Stainless-steel equipment must be installed no more than 30-days before filling the basins to protect the stainless-steel components.
2. The Contractor's responsibility is to protect the stainless-steel equipment's finishes and appearance as like-new without exceptions.

D. SWIVEL ATTACHMENTS

1. Install one swivel unit for each nozzle, sized for each nozzle.
2. Aim, calibrate, and adjust each nozzle's elevations when started and again as needed to provide the visual appearance desired by the Owner/Client.

3.31 UNDERWATER LIGHTING EXECUTION

A. GENERAL

1. Stainless-steel equipment must be installed no more than 30-days before filling the basins to protect the stainless-steel components.
2. The Contractor's responsibility is to protect the finishes and appearance of the stainless-steel equipment as like-new without exceptions.
3. Comply with the NEC requirements for installing wet-rated conductors, wires, and cabling within under-deck, underground, and underwater conduits.
4. Comply with State and Local Building Codes.
5. Observe and precisely follow the installation procedures and recommended requirements of the manufacturer of the products utilized without exception.
6. Locate the power supply and transformers a minimum of 9-inches [200 mm] above the maximum pool water elevation. Verify the designated location with the Landscape Architect.
7. Provide the following electrical components with the underwater lighting system:
 - a. One photo-cell (outdoors near the filter area).
 - b. One-24-hour time clock (Intermatic T-104R or equal) and relays connected to operate the underwater lights in conjunction with the required photo-cell.
 - c. Bonding, Earthing, & Grounding connections to UL listed (or equivalent certification) ground lugs or connectors.
8. Underwater junction box installations must include/incorporate only Re-Enterable Compound: 3M™ Scotchcast™ 2123 as manufactured by 3M Electrical Markets Division.
 - a. Photo-documentation is required for each junction box (before the cover is installed) when the Re-Enterable Compound has been installed.

- b. Lights, Junction Boxes, Cable Installation, & Potting: Provide the electrical installer's certifications relating to the proper installation of the underwater lights, junction boxes, the potting, all following the manufacturers' requirements & recommendations, the NEC, and local codes, without exception.

- 1) The Contractor must certify no stray current/voltage is released into the water basin.

- 9. Underwater lighting equipment manufacturer must provide a written certification, including written documentation of UL listing (or equivalent) and NEC compliance for underwater lighting equipment components in swimming pools (including UL/NEC required grounding).

B. UNDERWATER LIGHTING SYSTEMS FOR WATER FEATURES

- 1. Install underwater LED lights with a low-voltage power supplies/transformer and step-up power supplies/transformers.
 - a. Pools: 45-Watts LED in the color white
 - b. Spas: 26-Watts LED in the color white
 - c. Fountains & water features: RGBW with automation and in the sizes/power as identified in the Drawings

3.32 WATER TOYS, WET PLAY WITH ASSEMBLIES EXECUTION

A. GENERAL

- 1. The following types of such feature equipment are included:
 - a. signage related to the proper bather/riders' use,
 - b. water/wet play equipment
- 2. The Contractor's Delegated Engineer and the Manufacturer's Representative must provide written certifications before placing equipment into service and authorized use by bathers/riders/users.

3.33 NOT USED

3.34 NOT USED

3.35 NOT USED

3.36 NOT USED

3.37 TESTING, STARTING, & COMMISSIONING OF SYSTEMS

A. PIPING TEST

- 1. Refer to these Specifications for hydrostatic test (water-pressure testing) requirements for the water piping systems.
- 2. Refer to these Specifications for test (air pressure testing) requirements for only compressed air piping systems.
 - a. Critical: NO air pressure testing is allowed on water piping systems.
- 3. Refer to "Quality Control" for additional requirements during testing. The Contractor must submit a Completion Certificate of each water piping test and each compressed air test. Refer to "Submittals" for additional info.

B. ADJUSTMENTS

1. Continue to adjust and regulate the system under actual operating conditions until specified water quality levels are achieved and maintained.
2. Adjust as required to ensure water flow rates are attained.

C. CONCEALMENT

1. No piping work, fixtures, or equipment must be concealed or covered by any means before they have been successfully water-pressure tested, flow tested, and inspected by the local governmental authority having the authority and observed by one of the following:
 - a. Architect
 - b. Engineer
2. Work must be installed and tested as required by These Specifications and the code requirements and must be leak-tight before the work stage's regulatory inspection is requested.
 - a. If leaks are discovered, provide repairs and re-test.

D. BASIN & PIPE FILLING

1. Do not fill basins until structural curing times and 28-day strengths of the basins and the below list have been achieved. These filling procedures apply to:
 - a. Basin structural basin
 - b. Tile adhesive and grouting products
 - c. Contraction and expansion-joint assemblies, fillers, & materials.
 - d. Similar products
2. Water addition to the basin: Fill the basin with clean, potable water from the deepest end. Use a dampening-device attached to the fill hose to assist in the prevention of erosion or staining on the basins' finishes.
 - a. Do not cease the filling operation until the water level is at the waterline tiles.
3. The water-fogging (fogging) of the basin's walls and floor plaster finishes are the responsibility of the Installer:
 - a. Assist in preventing the basin's interior plaster from drying too rapidly by "fogging" (applying small spray droplets of water) to the natural stone/plaster/tile surfaces during the filling process.
 - 1) The installer must provide all necessary workforce requirements for this operation's success.
 - 2) Thoroughly water-fog entire interior surfaces every 60 minutes
4. The filling, start-up, and water chemistry implementation of the pool must be per the book's written procedures, "POOL SURFACES - PROBLEMS AND SOLUTIONS," 7th Edition by Techlines, Inc. and Randy Dukes.

E. COMMISSIONING & OPERATION OF EQUIPMENT

1. Coordinate the initial startup and operational period, installation, electrical, commissioning, and chemical completion activities.

- a. Oversee, perform, adjust, supervise the equipment's operation and be responsible for the proper functioning.
 - b. Make such changes, adjustments, or replacement of equipment as required for compliance with the Contract Documents.
 - c. Replace equipment, materials, & parts found to be defective.
2. The Contractor must demonstrate that the design pattern of the pool's recirculation flow with perimeter overflow system (gutters) provides 100% of the design flow through main drain piping and provides 100% of the design flow through perimeter overflow system piping.
 - a. When the pool or reservoir tank is equipped with a perimeter skimmer system (rather than the overflow system), the Contractor must demonstrate that the perimeter skimmer system provides a minimum of 80% of the design filtration flow through the skimmer system (or less flow only if explicitly allowed the local governmental authorities).

F. CHEMICAL ADDITION / WATER TREATMENT

1. Maintain water within the newly filled basin with a pH of 7.2 for a minimum of 3 days (with regular brushing at least twice daily of the entire pool surface) before adding pre-diluted chlorine.
2. Provide daily service (including specified chemicals and filter media) for the basin until the governing regulatory agency has issued a temporary operating permit or Owner's acceptance, whichever comes first.
3. Notify the Architect and This Engineer of System Startup forty-eight (48) hours in advance. Before startup, corroborate subsystems and safety features (including electrical circuit protection and electrical interlocking) have been tested and operated within the Contract Documents parameters.
4. Chemical Operational Parameters: Attain and maintain the following chemical operational parameters at startup, thru the 30-day maintenance period, and Substantial Completion.

	DISINFECTANT LEVELS	MIN.	IDEAL	MAX.
a.	Pool Free Chlorine, ppm [mg/L]	2.0	3.0	4.0
b.	Combined Avail. Chlorine, ppm [mg/L]	0.0	0.0	0.2
c.	Total Available Chlorine, ppm [mg/L]	2.0	3.0	6.2
d.	Bromine (when utilized)	2.0	3.0	4.0
e.	pH	7.3	7.4 - 7.5	7.6
f.	Total Alkalinity, ppm [mg/L]	80	100-110	120
g.	Total Dissolved Solids, ppm [mg/L]	0	0	1200
h.	Calcium Hardness, ppm [mg/L]	150	200 - 250	300
i.	Copper, Silver, Iron ppm [mg/L]	0	0	0.1
j.	Cyanuric Acid (Stabilizer), ppm [mg/L]	0	25 - 35	50

5. Provide a balanced water quality via the implementation of the "Langelier Saturation Index" (LSI). The LSI must be maintained between 0.0 and +0.3.
6. UV Equipment Commissioning:

- a. Commissioning by a qualified factory-trained technician is a prerequisite to a warranty-issuance for the Ultraviolet Chamber and Control Panel.
 - b. Supervise the installation of the electrical and control cabling connections.
 - c. Provide training for daily operation and maintenance during the commissioning process. Video training session and submit the recording per Division 01.
 - d. Demonstrate the operation of the UV sanitizer, including controls to de-activate the filtration pump(s).
7. Saline Chlorination Systems' Project Commissioning:
- a. Commissioning by a qualified factory-trained technician is a prerequisite to a warranty-issuance for the Saline Chlorination System and related Control Panel.
 - b. When a saline chlorination system is specified, no salt/saline solutions must be added to (or commissioned on) the basin water for 28 days after the basin's filtration system was commissioned. Water chemistry parameters are maintained for a minimum of 28 days.
8. Wet play equipment unit commissioning and safety certification:
- a. The Wet Play operations must be initiated, fully commissioned, and certified by an authorized, qualified agent employed by the wet play Manufacturer(s) and in cooperation with the Contractor & Owner. The Wet Play Manufacturer's commissioning requirements must consist of activities necessary to provide a fully functioning, safely-operating attraction certified as ready for public use, and include the following documentation for the Owner's frequent operational reference and training of safety attendants:
 - 1) Oversee the placement of manufacturer-deemed sufficient safety rules signs at the entrance and the termination of each water slide. The Rules contained in each sign must be originated and approved by each manufacturer or their authorized safety consultant(s) without exception.
 - 2) Provide the commissioning and start-up of pumps, including setting and recording (frequency or RPM) of variable frequency drive speeds.
 - 3) The setting, recording (% open), and marking of operating and balancing valve positions at the pump locations, slide tower, flow-meters, and slide supply connection locations.
 - 4) Recording of slide supply pump pressure and vacuum gauge readings (psi or inches Hg) and rate-of-flow flowmeters (GPM) at the time of the approved, commissioned slide/wet play water flows and valve settings.
 - 5) Recording of wet-play supply flow meter readings (GPM) at the date of the approved and commissioned wet play flows and valve configuration. Coordinate this work with the Contractor to assure feature flow meter installations are accurately functioning, complete, and properly-located on the supply piping before final commissioning and turnover to the Owner.
 - 6) Recording and marking of approved water level elevation range in the slide start tub. Permanently mark water elevation levels with a line and record the elevation measurement in inches above the floor.
 - 7) Provide a written commissioning report that includes the following information for each wet play unit:

- a) A written, manufacturer-approved entrance & exit signs at each unit.
- b) A descriptive narrative stating the minimum safety attendants (and their qualifications & training) required for each unit's safe operation and use.
- c) A narrative describing the wet play operations includes daily minimum visual inspections before allowing access to bathers/users each day, recommended loading procedures, verbal safety instructions to each user, routine unit operations, and unit operations during a safety emergency event.
- d) Record summary in table format of data collected in Items 1 through 8.
- e) Date, time, and initials of commissioning and safety agent for each recorded item 1 through 8.
- f) Name, signature, and date of the Manufacturer's authorized commissioning agent responsible for work above. The manufacturer's report must be signed and sealed by a locally licensed Professional Engineer paid for by the Manufacturer.

G. OPERATIONS & MAINTENANCE INSTRUCTION

1. Provide experienced pool operator-instruction by a certified pool operator.
2. Instructions must be provided for each operating pool shift. Each shift's instructions must be for not less than three (3) days (two (2) full day's operations and start-up, and one (1) full day shut-down assistance) after the pool has been filled and initially placed into operation.
 - a. During these periods, the Owner's designated representative(s) for operating shifts must be thoroughly instructed in phases of the pool's operation, including start-up, emptying, and winterizing procedures.
 - b. Before this instructor leaving the site, the instructor must obtain written certification from the Owner's designated representative acknowledging that the instruction periods have been completed and necessary operating information was provided.
3. Provide a DVD documenting training and operational requirements, including start-up, filtration operations, chemical handling operations, emptying, and winterizing procedures.
4. Provide an experienced operator-instructor employed by the respective wet play manufacturers for operations and commissioning after the wet-play units have been placed into operation.
 - a. During this period, the Owner's designated representative(s) must be thoroughly instructed in each phase of the wet-play assemblies' operation.
5. The Wet Play manufacturers must deliver one Operating and Maintenance (O&M) Manual in electronic file format (.pdf) to the Architect/Engineer/Owner for review and approval. Four bound hard-copy sets of the approved documents to the Owner. O&M Manual must include, but is not limited to, the following:
 - a. A narrative on the Wet Play operations, including recommended loading procedures and operation through each sequence.
 - b. Recommended user requirements including recommended signage and height and weight restrictions
 - c. A written Wet Play warranty and contact information.

- d. A written summary of the information provided during the Owner's Instructions per the above, including maintenance information and recommended maintenance program.
- e. A written Wet Play Commissioning Report, per the requirements above.

H. CLEAN-UP AND PROTECTION

- 1. After Section 13 1100 has been completed, clean-up work areas, remove equipment, excess materials, and debris. Protect pool(s) from damage until substantial completion. Remove and replace equipment, finishes, and materials chipped, cracked, abraded, improperly adhered, otherwise damaged, or deemed unacceptable by This Engineer.

I. MANUFACTURER CERTIFICATES OF INSTALLATION

- 1. Obtain written manufacturer's installation certificates stating the manufactured equipment is installed according to the manufacturers' instructions & recommendations and Contract Documents.
- 2. The Contractor must certify the following minimum listing of materials:
 - a. Non-slip tiles (for certified slip-resistance) on sloped and flat surfaces
 - b. Field-installed non-slip surfaces (for certified slip-resistance)
 - c. Tile adhesives (for specified shear strengths)
 - d. Epoxy-type adhesives and grouting (to assist in preventing efflorescence)
- 3. The Contractor must employ a 3rd-party testing firm to certify in writing the bonding/earthing/grounding systems' adequacy & effectiveness.

END OF SECTION 13 1100