SECTION 220800 - COMMISSIONING OF PLUMBING

Revise this Section by deleting and inserting text to meet Project-specific requirements.

See "Sustainable Design Considerations" Article in the Evaluations for a discussion of sustainable design requirements that may impact editing of this Section.

1. GENERAL
   * + 1. SUMMARY
          1. Section includes Cx process requirements for the following plumbing systems, assemblies, and equipment:

Retain or add systems below that are to be commissioned. Coordinate subparagraphs below with retained "Construction Checklists" Article under Part 3.

Domestic hot- and cold-water piping.

Gray-water piping and storage.

Sanitary waste and vent piping.

Storm drainage piping.

Rainwater retention piping and equipment.

Plumbing pumps.

General-service compressed-air piping and equipment.

Plumbing equipment.

Compressed-air piping and equipment for laboratory and healthcare facilities.

Vacuum piping and equipment for laboratory and healthcare facilities.

Medical gases piping, equipment, and alarms.

Chemical waste systems for laboratory and healthcare facilities.

Processed-water systems for laboratory and healthcare facilities.

<**Insert additional systems**>.

* + - * 1. Related Requirements:

Retain first subparagraph below because it contains the general Cx process requirements that apply to Cx of plumbing systems. If the work covered under Section 019113 "General Commissioning Requirements" is not to be performed by an independent contractor, it must be included under this or other sections of the Specification. Modify the Specifications accordingly.

Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.

For construction checklists, comply with requirements in various Division 22 Sections specifying plumbing systems, system components, equipment, and products.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project. Include only essential definitions or acronyms not well understood by the affected industry or trade.

* + - * 1. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
        2. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
        3. IAPMO: International Association of Plumbing and Mechanical Officials.
        4. IgCC: International Green Construction Code.
        5. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
      1. SUBMITTALS
         1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
         2. Manufacturer’s installation instructions shall be provided along with product data.
         3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
         4. Construction Checklists:

Retain one of two subparagraphs below. Retain first subparagraph for projects in which an independent CxA creates construction checklists. Retain second subparagraph for projects in which Contractor creates and submits construction checklists. Note that in order to conform to IgCC requirements, construction checklists must be prepared by the CxA who must be designated by the Director’s Representative to manage the Cx process. CxA must have the necessary training, experience, and equipment and be independent from the design team and the Contractor.

Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Contractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.

Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to plumbing to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements"[**, IAPMO "Green Plumbing and Mechanical Code Supplement,"**] and ASHRAE 202.

Retain "Test Equipment and Instruments" paragraph below if Contractor is to provide test equipment.

* + - * 1. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, provide the following:

Equipment/instrument identification number.

Planned Cx application or use.

Manufacturer, make, model, and serial number.

Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

Instrument or tool identification number.

Equipment schedule designation of equipment for which the instrument or tool is required.

Manufacturer, make, model, and serial number.

Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

* + - 1. QUALITY ASSURANCE
         1. Plumbing Testing Technician Qualifications: Technicians to perform plumbing Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.

Minimum [**three years'**] <**Insert time**> experience installing, servicing, and operating systems manufactured by approved manufacturer.

* + - * 1. Medical Gas Piping Systems Testing Technician Qualifications: Technicians to perform medical compressed-air, vacuum, and medical gas piping for laboratory and healthcare facilities system Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in mechanical systems, plumbing systems, or similar field. Degree requirement may be offset by three years' experience in servicing plumbing systems and gas piping for laboratory and healthcare facilities. Generally, required knowledge includes design and maintenance of gas piping for laboratory and healthcare facility systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of plumbing system equipment, assemblies, and systems.

Minimum [**three years'**] <**Insert time**> experience installing, servicing, and operating systems manufactured by approved manufacturer.

* + - * 1. Testing Equipment and Instrumentation Quality and Calibration:

Capable of testing and measuring performance within the specified acceptance criteria.

Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.

Be maintained in good repair and operating condition throughout duration of use on Project.

Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

* + - * 1. Proprietary Test Instrumentation and Tools:

Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

Be calibrated by manufacturer with current calibration tags permanently affixed.

Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

Plumbing system proprietary test instrumentation and tools become property of Director’s Representative at the time of Substantial Completion.

1. PRODUCTS (Not Used)
2. EXECUTION
   * + 1. Cx PROCESS
          1. Perform Cx process for plumbing systems in accordance with:

[IgCC, which requires compliance with ASHRAE 202 (Commissioning Process for Building Systems).]

[ASHRAE 202 ((Commissioning Process for Building Systems)).]

[Commissioning standards acceptable to the authority having jurisdiction.]

<Insert standard>.

* + - 1. CONSTRUCTION CHECKLISTS

Retain first paragraph below if construction checklists are to be prepared under Section 019113 "General Commissioning Requirements." Coordinate with "Construction Checklists" Paragraph in "Informational Submittals" Article.

* + - * 1. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**ASHRAE 202 (Commissioning Process for Building Systems).**] [**IgCC.**] [**IAPMO's "Green Plumbing and Mechanical Code Supplement."**] <**Insert Cx standard.**> Contractor performs the following:

Review plumbing preliminary construction checklists and provide written comments on Construction Checklist items where appropriate.

Return preliminary Construction Checklist with review comments within [**10**] <**Insert number**> days of receipt.

When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."

Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.

Retain first paragraph below if construction checklists are to be prepared by Contractor. Coordinate with "Informational Submittals" Article.

* + - * 1. Prepare preliminary detailed construction checklists for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**ASHRAE 202 (Commissioning Process for Building Systems).**] [**IgCC.**] [**IAPMO's "Green Plumbing and Mechanical Code Supplement."**] <**Insert Cx standard.**>

Submit preliminary construction checklists to CxA and Designer for review.

When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."

Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place as indicated Project events are completed and provide pertinent details and other information.

On projects subject to IgCC, the following plumbing systems must be commissioned as a minimum. Delete systems not applicable to Project. Add system as required for the Project. On projects not subject to IgCC, paragraphs below may be modified as required to suit Project.

* + - * 1. Systems Required to Be Commissioned under IgCC:

Domestic hot-water systems and controls.

Water-pumping and -mixing systems over 5 hp and purification systems.

Irrigation system performance that uses more than 1000 gal. per day.

Renewable energy systems and energy storage systems.

* + - * 1. Additional Systems Required to Be Commissioned:

Additional systems may be commissioned as required. Revise subparagraphs below to indicate Cx requirements on this Project.

Facility water-distribution piping, including the following:

Domestic[**and fire-suppression**] water piping, fittings, and specialties outside the building.

Pumps, motors, accessories, and controls.

Outdoor water-storage tanks.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Heat tracing.

Vibration isolation[**and seismic restraints**].

Domestic water piping, including the following:

Domestic cold- and hot-water piping, fittings, and specialties inside the building.

Pumps, motors, accessories, and controls.

Sleeves and sleeve seals.

Indoor water-storage tanks.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Heat tracing.

Vibration isolation[**and seismic restraints**].

Sanitary waste and vent piping, including the following:

Gravity and forced-main sewerage piping, fittings, and specialties.

Sanitary waste interceptors.

Pumps, motors, accessories, and controls.

Drains.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Heat tracing.

Vibration isolation[**and seismic restraints**].

Gray-water piping, including the following:

Piping, fittings, and specialties.

Pumps, motors, accessories, and controls.

Storage tanks.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Heat tracing.

Vibration isolation[**and seismic restraints**].

Storm-water piping, including the following:

Drainage piping, fittings, and specialties.

Pumps, motors, accessories, and controls.

Drains and collection basins.

Rainwater-collection and storage equipment.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Heat tracing.

Vibration isolation[**and seismic restraints**].

Plumbing fixtures, including the following:

Water closets, supports and connections, supplies, and flush valves.

Urinals, supports and connections, supplies, and flush valves.

Lavatories, supports, supplies, drain connections, and faucets.

Sinks, supports, supplies, drain connections, and faucets.

Tubs, drain connections, and faucets.

Showers, supplies, drain connections, and faucets.

Wash fountains, supplies, drain connections, and faucets.

Emergency plumbing fixtures, supplies, drain connections, and controls.

Drinking fountains, supplies, and drainage connections.

General-service compressed-air piping, including the following:

Piping, fittings, and specialties inside the building.

Compressors, motors, accessories, and controls.

Compressed-air outlets and connections.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Vibration isolation[**and seismic restraints**].

Compressed-air piping for laboratory and healthcare facilities, including the following:

Piping, fittings, and specialties inside the building.

Compressors, motors, accessories, and controls.

Medical gas alarms.

Compressed-air outlets and connections.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Vibration isolation[**and seismic restraints**].

Vacuum piping for laboratory and healthcare facilities, including the following:

Piping, fittings, and specialties inside the building.

Vacuum pumps, motors, accessories, and controls.

Medical gas alarms.

Vacuum terminal units and connections.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Vibration isolation[**and seismic restraints**].

Gas piping for laboratory and healthcare facilities, including the following:

[**Carbon-dioxide**] [**helium**] [**nitrogen**] [**nitrous-oxide**] [**and**] [**oxygen**] piping, fittings, and specialties inside the building.

Storage tanks, manifolds, mounting devices, and accessories.

Medical gas alarms.

Medical gas terminal units and connections.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Vibration isolation[**and seismic restraints**].

Processed-water piping for laboratory and healthcare facilities, including the following:

Water piping, fittings, and specialties inside the building.

Water-purification equipment, accessories, and controls.

Pumps, motors, accessories, and controls.

Sleeves and sleeve seals.

Meters and gauges.

General-duty and specialty valves.

Hangers and supports.

Heat tracing.

Vibration isolation[**and seismic restraints**].

<**Insert additional systems**>.

* + - 1. Cx TESTING PREPARATION
         1. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.
         2. Certify that plumbing system instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and that all systems are set to and maintaining set points as required by the design documents.
         3. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
      2. Cx TEST CONDITIONS
         1. Perform tests using design conditions, whenever possible.

Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.

Cx test procedures may direct that set points be altered when simulating conditions is impractical.

Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

* + - * 1. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
        2. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.
      1. Cx TESTS COMMON TO PLUMBING SYSTEMS
         1. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.
         2. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response compared to acceptance criteria.
         3. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
         4. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 22 Sections specifying plumbing systems and equipment.
         5. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

Cx Construction Checklist verification tests.

Cx Construction Checklist verification test demonstrations.

* + - 1. CONSTRUCTION CHECKLIST EXAMPLES

Specific test procedures are to be developed by the CxA or Contractor. Paragraphs below represent a potential outline of procedures for certain typical systems and are provided as examples. Revise as required.

* + - * 1. Vibration Isolation in Plumbing Systems:

Prerequisites: Acceptance of results of construction checklists for vibration[**and seismic**] control devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**]

Components to Be Tested:

Vibration isolation control devices in plumbing systems.

[**Seismic control devices for proper device selection and mounting.**]

Support systems.

Test Purpose: Evaluate effectiveness of vibration isolation[**and proper installation of seismic**] control devices.

Test Conditions: Measure vibration of the facility structure at [**three**] <**Insert number**> locations designated by Director’s Representative's witness at the following operating conditions:

Retain first three subparagraphs below if isolated equipment operates at variable speed. Delete if isolated equipment operates at constant speed.

Maximum speed.

Minimum speed.

Critical speed.

Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

Retain "Supervision of Alarms in Plumbing Systems" paragraph below for plumbing system alarms that are monitored or supervised by other systems, such as building management systems or security- or alarm-monitoring services.

* + - * 1. Supervision of Alarms in Plumbing Systems:

Prerequisites: Acceptance of results of construction checklists for plumbing systems specified in the following Sections:

Section 221216 "Facility Elevated, Potable-Water Storage Tanks.”

Section 221329 "Sanitary Sewerage Pumps."

Section 221429 "Sump Pumps."

Section 223400 "Fuel-Fired, Domestic-Water Heaters."

Section 226113 "Compressed-Air Piping for Laboratory and Healthcare Facilities."

Section 226313 "Gas Piping for Laboratory and Healthcare Facilities."

Test Scope:

[**Supervised**] [**Monitored**] plumbing system alarms.

Test Purpose:

Verify reporting of [**supervised**] [**monitored**] plumbing alarm at [**building management system**] [**security monitoring service**] [**alarm monitoring service**] [**other alarm monitoring system**] <**Insert system**>.

Test Conditions:

Alarm monitoring systems operating in normal, automatic mode.

Activate [**supervised**] [**monitored**] plumbing alarms, one at a time.

Acceptance Criteria:

Activation of [**supervised**] [**monitored**] plumbing alarm generates alarm at [**building management system**] [**security monitoring service**] [**alarm monitoring service**] [**other alarm monitoring system**] <**Insert system**> control panel.

Retain "Plumbing Meter Reporting" paragraph below for water meters in plumbing systems connected to recording equipment or systems, such as building management systems.

* + - * 1. Plumbing Meter Reporting:

Prerequisites: Acceptance of results of construction checklists for plumbing systems specified in the following Sections:

Section 221119 "Domestic Water Piping Specialties."

Retain first subparagraph below for domestic water softeners with water meters connected to recording equipment or systems.

Section 223100 "Domestic Water Softeners."

Test Scope:

[**Supervised**] [**Monitored**] plumbing system water meters.

Test Purpose:

Verify accuracy of reporting of [**supervised**] [**monitored**] plumbing system water meters at [**building management system**] [**utility management service**] [**other utility consumption management system**] <**Insert system**>.

Test Conditions:

Plumbing system water meter recording systems operating in normal, automatic mode.

Compare cumulative consumption data at plumbing system water meter recording systems with independent, calibrated, flow-measuring instrumentation under the following conditions:

Low Flow: [**1**] <**Insert number**> percent of maximum design flow rate for a period of [**four hours**] <**Insert time**>.

High Flow: [**80**] <**Insert number**> percent of maximum design flow rate for a period of [**20 minutes**] <**Insert time**>.

Activate [**supervised**] [**monitored**] plumbing alarms, one at a time.

Acceptance Criteria:

Cumulative flow reported for low-flow condition is within [**5**] <**Insert number**> percent flow recorded by calibrated flow-measuring instrumentation.

Cumulative flow reported for high-flow condition is within [**1**] <**Insert number**> percent flow recorded by calibrated flow-measuring instrumentation.

* + - * 1. Heat Tracing in Plumbing Systems:

Prerequisites: Acceptance of results of construction checklists for heat tracing specified in heat-tracing systems. Comply with requirements listed in Section 220533 "Heat Tracing for Plumbing Piping."

Equipment and Systems To Be Tested:

Self-regulating, parallel-resistance heating cables.

Heater trace circuit controller.

Test Purpose:

Evaluate response to ambient temperature below freeze-protection set point.

Evaluate heating cable fault alarm.

Test Conditions:

Subject temperature sensor to temperature approximately [**3 deg F**] <**Insert value**> above freeze-protection set point (initial set point [**41 deg F**] <**Insert value**>). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is energized.

Subject temperature sensor to temperature approximately [**3 deg F**] <**Insert value**> below freeze-protection set point (initial set point [**41 deg F**] <**Insert value**>). Monitor sensed temperature with a calibration-grade thermometer. Gradually change set point or sensed temperature until freeze-protection circuit is de-energized.

Simulate an electrical fault on the heating cable.

Acceptance Criteria:

Freeze-protection circuit is energized at set-point temperature of minus 2 deg F.

Freeze-protection circuit is de-energized at set-point temperature of plus 2 deg F.

Heater trace circuit controller initiates an alarm of cable fault. Alarm is correctly reported at the fire-alarm control panel.

* + - 1. Cx TESTS FOR COMPRESSED-AIR SYSTEMS
         1. Air Compressor Run Time:

Prerequisites:

Acceptance of results of construction checklists specified in the following:

Section 221519 "General-Service Packaged Air Compressors and Receivers."

Section 226119 "Compressed-Air Equipment for Laboratory and Healthcare Facilities."

Test Scope:

Air compressors in plumbing systems.

Associated compressed-air piping, valves, and appurtenances.

Associated air pressure controllers.

Test Purpose: Evaluate air compressor run time and number of compressor starts.

Test Conditions:

Keep compressed air openings closed during test.

For systems with multiple compressors, lock out compressor motors on all but one compressor. Repeat test for each compressor in turn.

Record number of air compressor motor starts during a 14-day period.

Record air compressor motor run time during the same 14-day period.

Acceptance Criteria:

Number of compressor motor starts during test period shall not exceed [**20**] <**Insert number**>.

Compressor motor run time during test period shall not exceed [**60 minutes**] <**Insert time**>.

* + - 1. Cx TESTS FOR VACUUM SYSTEMS

Retain "Vacuum Pump Run Time" paragraph below for vacuum equipment for laboratory and healthcare facilities.

* + - * 1. Vacuum Pump Run Time:

Prerequisites:

Acceptance of results of construction checklists for vacuum equipment for laboratory and healthcare facilities.

Test Scope:

Vacuum pumps in plumbing systems.

Associated vacuum piping, valves, and appurtenances.

Associated vacuum pressure controllers.

Test Purpose:

Evaluate vacuum pump run time and number of vacuum pump starts.

Test Conditions:

Keep vacuum piping openings closed during test.

For systems with multiple vacuum pumps, lock out vacuum pump motors on all but one pump. Repeat test for each vacuum pump in turn.

Record number of vacuum pump motor starts during a 14-day period.

Record vacuum pump motor run time during the same 14-day period.

Acceptance Criteria:

Number of vacuum pump motor starts during test period shall not exceed [**20**] <**Insert number**>.

Vacuum pump motor run time during test period shall not exceed [**60 minutes**] <**Insert time**>.

* + - 1. Cx TESTS FOR PROCESSED-WATER SYSTEMS
         1. Processed-Water System Tests:

Prerequisites: Acceptance of results of construction checklists specified for processed-water systems. Comply with requirements in Section 226713 "Processed Water Piping for Laboratory and Healthcare Facilities" and Section 226719 "Processed Water Equipment for Laboratory and Healthcare Facilities."

Test Scope:

Processed-water equipment in plumbing systems.

Associated processed-water piping, valves, and appurtenances.

Processed-water point-of-use fixtures.

Test Purpose: Evaluate processed-water quality at points of use.

Test Conditions:

Operate water-processing equipment and circulation pumps in normal automatic mode for seven days prior to the test.

Collect processed-water samples from points of use.

Collect and handle water samples in accordance with analytical laboratory recommendations.

Document that the following parameters meet minimum standards required for the specified grade of processed water, as applicable:

Retain first nine subparagraphs below that apply to processed-water type or grade specified in Section 226713 "Processed Water Piping for Laboratory and Healthcare Facilities" and Section 226719 "Processed Water Equipment for Laboratory and Healthcare Facilities."

Resistivity.

pH.

Total organic carbon (TOC).

Sodium.

Chloride.

Total silica.

Microbial.

Endotoxin.

Bacteria.

Acceptance Criteria:

Measured processed-water parameters shall meet the following criteria:

Retain subparagraphs below that correspond to subparagraphs retained above.

Resistivity: [**10**] <**Insert value**> megohms.

pH: [**6**] <**Insert value**> units.

TOC: [**500**] <**Insert value**> ppb.

Sodium: [**5**] <**Insert value**> ug/L.

Chloride: [**5**] <**Insert value**> ug/L.

Total Silica: [**3**] <**Insert value**> ug/L.

Microbial: [**10**] <**Insert value**> CFU/mL.

Endotoxin: [**0.01**] <**Insert value**> EU/mL.

Bacteria: [**10 CFU/100 mL**] <**Insert values**>.

END OF SECTION 220800