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ADDENDUM NO. 2

Date: September 10, 2026
Project Name: MAWSS C.C. Williams Headworks Rehabilitation and Odor Control
Owner: Mobile Area Water and Sewer System
Garver Project No. W10-2402007

This addendum shall be a part of the Plans, Contract Documents and Specifications to the same extent as though it were originally included therein, and it shall supersede anything contained in the Plans, Contract Documents, and Specifications with which it might conflict. This addendum, including all attachments, shall become part of the Contract and all provisions of the Contract shall apply thereto, with exception of any items listed under "Other Project Information" at the end of this Addendum No. 2, which are supplements provided for the Contractor's convenience. The time provided for completion of the Contract has not been changed as noted in this addendum. Acknowledgement of receipt of this addendum must be noted in the appropriate section of the Proposal and included with the Contract Documents.

A. PART 3 - TECHNICAL SPECIFICATIONS

1. **Remove the following specification sections in their entirety and replace with the same, attached hereto:**

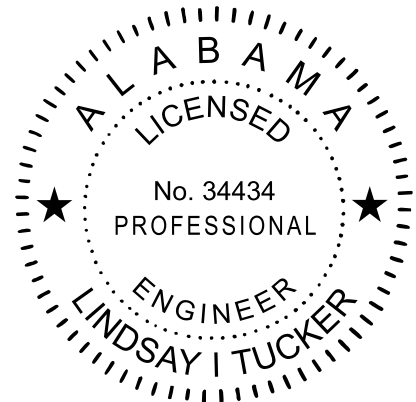
- a. **44 11 29 Bio-Trickling Filter Odor Control System**

By: _____

Lindsay I. Tucker, P.E.
Project Manager

Attachments:

- A. Specifications
 1. 44 11 29 Bio-Trickling Filter Odor Control System



END OF ADDENDUM NO. 2

SECTION 44 11 29 – BIO-TRICKLING FILTER ODOR CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes:

1. The work necessary to design, furnish, and install one Biotrickling Filter odor control system as specified herein. The Headworks shall be treated with one Bio-Trickling Filter Tower (10BTF1) and one Carbon Adsorber Tank (10CP1). Each odor control system consists of Biotrickling Filter (BTF) tower, Carbon Adsorber Tank, fan(s), flow control dampers, internal structural members, media with support grating, mist eliminator, internal piping, liquid distributor(s), and Process Controls. Each Process Control system shall include: a nutrient feed system, electrical controls, irrigation valves, recirculation pump, nutrient storage tank, water control panel, and all necessary accessories as described in this specification and the contract drawings.

B. Related Sections:

1. Section 01 40 00 – Quality Requirements
2. Section 05 05 19 - Post-Installed Anchors
3. Section 05 50 00 - Metal Fabrications
4. Section 23 33 00 - Air Duct Accessories
5. Section 40 61 96 - Process Control Descriptions - General
6. Section 40 61 96.1 - Process Control Descriptions - Odor Control
7. Section 44 61 16 - Carbon Adsorber Odor Control System

1.2 REFERENCES:

A. ASTM International:

1. C581 – Determining Chemical Resistance of Thermosetting Resins used in Glass Fiber Reinforced Structures Intended for Liquid Service.
2. C582 – Contact-Molded Reinforced Thermosetting Plastic Laminates for Corrosion Resistant Equipment.
3. D638 – Test for Tensile Properties of Plastics.
4. D695 – Test for Compressive Properties of Rigid Plastics.
5. D746 – Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
6. D790 – Test for Flexural Properties of Plastic.
7. D883 – Standard Nomenclature Relating to Plastics.
8. D1505 – Test Method for Density of Plastics by the Density Gradient Technique.
9. 1693, Test Method for Environmental Stress Cracking of Ethylene Plastics.
10. D2310 – Machine Made Reinforced Thermosetting Resin Pipe.
11. D2563 – Recommended Practice for Classifying Visual Defects in Glass Reinforced Laminated Parts.
12. D2583 – Test for Indentation Hardness of Plastics by Means of a Barcol Impresser.
13. D2996 – Filament Wound, Reinforced Thermosetting Polyester Chemical Resistant Tanks.
14. D3299 – Filament Wound Glass Fiber Reinforced Polyester Chemical Resistant Tanks
15. D4097 – Contact Molded Fiber Reinforced Thermoset Chemical Resistant Tanks.

B. NBS Voluntary Product Standard:

1. PS15-69 Custom Contact Molded Reinforced Polyester Chemical-Resistant Process Equipment.

1.3 DESCRIPTION

- A. System Description: It is the intent of this specification that one complete Biotrickling Filter system be provided by a single Manufacturer having complete system responsibility. Each system shall include, but NOT be limited to:
- | | | |
|-----|--|------------------|
| 1. | Biotrickling Filter Tower | 10BTF1 |
| 2. | Carbon Adsorber Tank | 10CP1 |
| 3. | Fans | 10F1, 10F2, 10F3 |
| 4. | Control Dampers | 10CD1 - 10CD7 |
| 5. | Recirculation Pump | 10P1 |
| 6. | Nutrient Feed & Dilution System | 10P2 |
| 7. | Water Control Cabinet | 10LCP1 |
| 8. | Electrical Control Cabinet | 10CP1 |
| 9. | Nutrient Storage Tank | |
| 10. | Mist Eliminator Attachments of tanks to ends of piping. | |
| 11. | Lateral bracing for vertical pipe segments at BTF tower. | |
| 12. | Aluminum Ladder and Platform for BTF Tower. | |
| 13. | Aluminum Ladder and Platform for Carbon Adsorber Tank | |
- B. The components listed above shall be installed to form a complete and operational biological odor control system in accordance with the requirements specified in this section. The drawings show minimum features and equipment required for the system. The carbon media polishing systems will be described in Section 44 61 16 - Carbon Adsorber Odor Control System.
- C. The cost of any other changes and modifications to mechanical, structural, electrical, and emergency electrical facilities necessary to adapt alternate equipment to the layout and design shown shall be borne by the Contractor. Clearances shown on the Drawings shall be maintained. Any such proposed changes or modifications are subject to review and acceptance of the Owner. Any costs associated with the engineering review shall be borne by the Contractor.
- D. Coordination:
1. To ensure that all the equipment is properly coordinated and will function in accordance with the requirements of the Contract Documents, the Contractor shall obtain all equipment specified herein from an odor reduction scrubber Manufacturer who shall have vested unit responsibility for the proper function of the complete system. However, The Contractor shall retain ultimate responsibility under this Contract for equipment coordination, installation, operation and guarantee, and the Contractor shall furnish and install all labor, equipment, materials, appurtenances, specialty items and services NOT provided by the supplier but required for a complete and operable system. The equipment covered by this specification is intended to be standard equipment of proven ability as manufactured by reputable concerns having extensive experience in the production of such equipment. The equipment furnished shall be manufactured and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed as shown and as specified in the Contract Documents.

1.4 QUALITY ASSURANCE

- A. Manufacturer:
1. The products furnished under this section shall be of a Manufacturer who has been regularly engaged in the design and manufacture of odor control equipment for a minimum of ten years and biological odor control for eight years. Any costs associated with engineering review of an alternate supplier shall be submitted by a Contractor with all costs of evaluation including site visits be borne by the Contractor.

1.5 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01 33 00 - Submittal Procedures.
- B. In addition, the following specific information shall be provided:
 - 1. The Manufacturer shall submit detailed description of the laminate and the type of reinforcing to be used and a letter from the resin Manufacturer stating:
 - a. That the laminate and reinforcing material used complies with the specifications.
 - b. That the resin will meet the performance requirements stated and is suitable for the service conditions specified herein and the fabrication technique proposed.
 - 2. All material properties used in the calculations shall be derived from actual destructive testing of equivalent laminates.
 - 3. Detailed shop drawings showing weights and dimensions of equipment, all nozzles and manways, wall thicknesses, laminate make-up, fabrication techniques, anchor bolt layout, roof access areas, platforms, ladders, fall prevention systems, pipe attachments and accessories, and construction materials for all equipment. Drawings and description of nozzle and liquid distribution system to include spray pattern, pressure drop, liquid flow rate, support system details and materials of construction.
 - 4. Submit fan data sheets with a description of the proposed fan, fan size, type, arrangement, construction materials, weight, motor horsepower, motor type, power supply, frame size, sheave sizes, belts size, number, and length. Submittal shall include pertinent equipment dimensional data, and a performance curve showing the fan operating point and range. A list of accessories to be furnished shall be included.
 - 5. Design structural calculations for each vessel and their anchorage to supporting construction, signed and sealed by a professional engineer registered in Alabama.
 - a. Provide signed and sealed calculations for the biotrickling filter systems, including vessels, roof access areas, ladders, and safety rails to verify compliance with the design criteria indicated in Section G.2 and all applicable OSHA requirements.
 - 6. Current design does not include wiring restraints. If wiring restraints are required based on calculations, modifications to the biotrickling filter design, including pad size to allow appropriate access space, shall be performed at no additional cost to the Owner. A description of media including but not limited to, pressure drop through media, liquid hold-up data, and media physical characteristics.
 - a. Complete data on the head loss for the air flow through the media at both design air flow rates.
 - b. Details of filter media supports.
 - 7. A description of the proposed quality requirements program that will be used during the manufacturing of the scrubber. Include the resume of the quality requirements manager.
 - 8. A schedule for the scrubber's fabrication along with the location of the fabrication site.
 - 9. Written instructions as to the recommended methods for unloading, storing, and installing the fiberglass scrubbers and recommended lifting and handling procedures.
 - 10. Submit listing of previous installations and references to the Engineer. The proposed vessel fabricator shall demonstrate an experience record of at least 5 years with the Manufacturer of filament wound fiberglass vessels for industrial service.
 - 11. Submit written installation procedures.
 - 12. Submit factory test certifications.
 - 13. Submit Manufacturer recommended support ledge requirements for liquid distributor, packing support, and mist eliminator. Submit recommended influent feed pipe design for liquid distributor.
 - 14. Submit certification indicating the quality requirements, testing, and inspection has been completed and standards specified herein have been met prior to shipment to the jobsite.
 - 15. Submit color chart describing the available colors for the vessel exterior pigment color to be selected by the Engineer and/or Owner.
 - 16. Schematic of the system, showing all components and controls.
 - 17. Electrical data for all equipment.

18. Information and data for all instrumentation and controls and for the control panel, including wiring and interconnection diagram.
19. Control panel layout drawing and fabrication details.
20. Complete listing of physical and chemical process parameters required for proper operation of the system.
21. In addition, the following data for motors shall be provided:
 - a. Motors:
 - 1) Name and Manufacturer
 - 2) Type and model
 - 3) Bearing type and lubrication
 - 4) Horsepower rating and service factor
 - 5) Temperature rating
 - 6) Full load rotative speed
 - 7) Net weight
 - 8) Efficiency at rated load
 - 9) Full load current
 - 10) Overall dimensions

1.6 MANUFACTURER'S SERVICES

- A. The system Manufacturer's representative shall be present at the job site for the following time period; travel time excluded:
 1. One day for each system for inspection and certification of the installation, can be performed concurrently if the schedule allows.
 2. One day to train Owner's staff in operation of both systems to include two hours of classroom and two hours at the site(s)
 3. Two days for initial startup and monitoring for each of the systems can be performed concurrently if the schedule allows.
 4. One follow-up trip for two days, 2 weeks after startup to assess the acclimation process, adjust to steady state operation. Can be performed concurrently if the schedule allows.
 5. One trip for two days 3 – 4 weeks after startup to perform performance testing, can be performed concurrently if the schedule allows.
 6. One trip for two days within one month of warranty expiration to perform performance testing. Tests shall meet performance requirements at design conditions. Refer to Subsection 3.3, PERFORMANCE TESTING for further requirements.
 7. A minimum of four trips is required.

1.7 DELIVERY AND INSTALLATION

- A. Components and accessories shall be shipped in safe packaged containers to prevent damage. Installation of components at the job site shall be in strict compliance of Manufacturer's recommendations and under adequate supervision provided by the system supplier.

1.8 OPERATION AND MAINTENANCE MANUALS

- A. Six (6) copies of a 3-ring bound O&M manual shall be provided.
- B. One copy of a digital pdf O&M manual shall be provided.

1.9 MANUFACTURER'S WARRANTY

- A. The Contractor shall procure and provide copies of all certified Manufacturer's warranty. The complete system, including accessories and components, shall be warranted for two years by the Manufacturer having unit responsibility.

- B. Provide warranty for a period of 2 years after the Final Acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer shall promptly repair or replace the defective equipment without additional cost to the Owner.
- C. Provide BTF media warranty for a period of 10 years after the Final Acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer shall promptly repair or replace the defective equipment without additional cost to the Owner.
 1. Media failure includes increase in pressure drop through the media such that the specified airflow rates are not achievable with the installed equipment and/or the failure of the media to meet specified odorant removal levels.

PART 2 - PRODUCTS

2.1 BIOTRICKLING FILTER

- A. General:
 1. Each Biotrickling Filter system shall be vertical, countercurrent flow, and shall consist of an FRP vessel, biological media, spray nozzle, mist eliminator, sump, and all internals. The process support equipment, which includes the nutrient reservoir, auxiliary sump, recirculation pump(s), water control cabinet(s), and electrical cabinet shall be included, as necessary, pre-piped, pre-wired, and factory tested on a integrated single Process Support and Control skid.

2.2 MANUFACTURERS

- A. Where a Manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to the performance, functions, features and materials of construction as specified herein. Section 44 61 16 - Bio-Trickling Filter and Carbon Adsorber Odor Control System shall be of same Manufacturer.
 1. Daniel Mechanical
 2. BioAir
 3. ECS
 4. Evoqua

2.3 SERVICE CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. BTF Design Specifications and Performance Requirements. BTF shall be sized for minimum empty bed contact time and performance requirements at the higher airflow. Air channeling within BTF at the lower airflow shall not be acceptable.

	10BTF1	
Design Air Changes per Hour	30	15
Design Air Flow Rate, cfm	6,300	3,150
Minimum empty bed contact time, seconds	15	30
Average Inlet H₂S Concentration, ppm(v)¹	200	250
Peak Inlet H₂S Concentration, ppm(v)¹	450	525
Odor Removal % H₂S, % Overall (REVISED BY ADDENDUM NO. 1)	99%, 90% or ≤0.5 ppmv in the outlet,	99%, 90% or ≤0.5 ppmv in the outlet,

	whichever is less stringent	whichever is less stringent
Odor Removal % Overall (REVISED BY ADDENDUM NO. 1)	90% or ≤ 0.5 ppmv in the outlet, whichever is less stringent	90% or ≤ 0.5 ppmv in the outlet, whichever is less stringent
Notes: 1. Average and Peak Inlet H ₂ S Concentrations listed are estimated inlet concentrations after the headworks headspace has been diluted at the specified ventilation rates. 2. Average and Peak H ₂ S Concentrations measured in the headworks headspace are 1,406 ppm and 3,150 ppm, respectively. The concentrations were measured with stagnant air and do not include any dilution from ventilation.		

- B. All components of the odor control system shall be compatible with the conditions and constituents to which they will be subjected to during normal operation. Compounds with which the materials of construction must be compatible with include, but are not limited to:
1. Hydrogen sulfide
 2. Carbonyl sulfide
 3. Methyl mercaptan
 4. Dimethyl sulfide
 5. Carbon disulfide
 6. Dimethyl disulfide
- C. Service Conditions for each Odor Control System.
1. Service Conditions:
 - a. Ambient Air Temperature Range: 40–110°F (5–50°C)
 - b. Entering Air Temperature Range: 40–100°F (5–40°C)

2.4 MATERIALS AND CONSTRUCTION

- A. Fiberglass Vessel:

	10BTF1
Air Flow Rate, cfm	6,300
Number of Towers	1
Minimum Number of Media Levels per Tower	1

- B. Materials & Construction:
1. The Biotrickling Filter shall be cylindrical tower in shape with upflow air passage and countercurrent liquid flow. Vessel size and configuration shall be as shown on the drawings. Unit shall be complete with flanges, nozzles, manways, lifting lugs, anchors, and other appurtenances.
 - a. Vessel diameter shall not exceed 10 feet.
 2. The vessel, including its anchorage to supporting construction and all supported attachments, shall be designed to meet all applicable requirements of the governing building code adopted by the jurisdiction. For governing building code, wind speed and exposure, and seismic parameters, see the Structural Notes in the Drawings. Structural analysis shall be performed in accordance with the edition of ASCE 7-"Minimum Design Loads and Associated Criteria for Buildings and Other Structures" adopted by the governing building code.
 3. The vessel shall be filament wound in accordance with ASTM D3299. The vessel shall be designed for positive pressure service conditions as specified for Type II Grade 1 tanks in

ASTM D3299. Any fabrication by hand lay-up shall NOT be acceptable. Any vessel made of PVC, polypropylene, or any other material shall NOT be acceptable. A 10:1 safety factor shall be used for internal pressure loadings and a 5:1 safety factor shall be used for external and vacuum loadings. Contact molded components and accessories, including scrubber baffles, shall be fabricated in accordance with ASTM D4097 and PS 15-69. The resin will be exposed continuously to chemical scrubbing liquid and gas as listed in the service conditions above. The resin shall be capable of continuous exposure to H₂SO₄ concentrations up to 5% at temperatures up to 210°F. Without exception the resin shall be vinyl ester ~~Hetron 922 by Allnex~~, CoRezyn CORVE 8401 by Interplastic, Derakane 510B-400P by Ashland Chemical, or pre-approved equal. **Flame spread rating shall be Class 1.** Dual media systems that utilize polyester resin as the structural layer and vinyl ester as the corrosion shall NOT be allowed. **(REVISED BY ADDENDUM NO. 1)**

4. The laminate shall consist of a single resin rich layer, with Nexus 111-00010, C-glass veil, or approved equal reinforcement followed by two 1-1/2-ounce layers of random chopped strand glass, fully wetted out with resin. This interior surface shall yield a minimum 100-mil thick corrosion barrier. Filament wind over this to the required thickness. Exterior surface coat shall be paraffinated, complete with ultraviolet screener such as UV-9. No thixotropic or other additives shall be used. The pigment tone shall be selected by the Owner during the submittal.
5. The minimum properties of filament wound laminate shall be as specified in ASTM D3299.
6. The minimum properties of contact molded laminate shall be as follows:
 - a. Minimum glass content 35%
 - b. Tensile strength 17,000 psi
 - c. Tensile modulus 1,400,000 psi
 - d. Flexural strength 27,000 psi
 - e. Flexural modulus 1,000,000 psi
7. Anchorage: Each tank shall be furnished with concrete anchors and hold down lugs, complete with 316 stainless steel plates, bolts, nuts, and washers for proper anchoring of the tank as required by the design calculations.
 - a. Manufacturer shall provide anchor requirements and locations to contractor.
8. Lifting lugs shall be provided for use in transporting and placing the vessel.
9. Visual defects shall be better than Level II on the inside of the vessel and better than Level III on the outside in accordance with ASTM D2563.
10. Tower components shall be preassembled at the point of fabrication. Preassembly will NOT require all joints to be factory assembled, but all joints shall be prepared for filed fabrication and square within plus or minus 3/16 inch. Each matched piece shall then be numbered correspondingly. All FRP work shall be protected from atmospheric or otherwise induced conditions of adverse temperatures, moisture, wind, or blowing dust and sand and other contaminants that would adversely affect the laminate or joint construction. The protective means shall be provided during the construction and curing period.
11. Other than those associated nozzles, couplings, manways, and top and bottom heads, the towers shall be filament wound in one piece with no more than one joint.
12. All metal hardware shall be 316 stainless steel.
13. Sizes of manways shall be as shown on the Drawings, or as required for normal routine maintenance and shall be in accordance with ASTM D3299. As a minimum, manways shall be provided for access to the sump, bottom of EACH media level, nozzle inspection and top of packing, media replacement, and mist eliminator for each tower. Bolted manways shall be provided with 1/8-inch thick full face EPDM gaskets with 316 stainless steel bolts. Provide a transparent blind flange to view operation of the nozzles and allow inspection of the media.
14. Flanged nozzles, double flanged gusseted nozzles, bottom drain nozzle, and threaded full couplings shall be provided as required. Flanged nozzles with 1/8-inch thick EPDM

- full-face gaskets of 60 durometer shall be provided by the supplier. Press-molded flanges are NOT acceptable. Threaded full couplings shall be PVC.
15. The bottom or reservoir section, as required for system operation, shall include air inlet connection, make-up water connection, recirculation pump suction connection, drain, overflow, and sump low level indicator fabricated of SCH 80 clear PVC pipe.
 16. Each bioscrubber sump shall be equipped with a titanium or hastelloy grounding rod. The grounding rod will provide an earth ground for the bioscrubber solution. The Contractor shall install a grounding rod adjacent to the bioscrubber for connection to the lugs.
- C. Media Support:
1. Media support plates shall be VINYL ESTER FRP GRID type rated at 150 psi. Free area shall be a minimum of 95% of the cross-sectional area of the tower. Packing support plates and mid span supports shall be suitable to support weight of the packing specified plus entrained recirculation solution. Opening size shall NOT allow passage of packing media in any random orientation. Construction shall be fiberglass constructed of vinyl ester resins. Furnish supplier instructions for placement and removal of the packing support in and out of the tower.
- D. Biological Media:
1. The media material shall be synthetic reticulated polyurethane foam, resistant to the corrosive attack of acids. The media configuration shall promote thorough mixing and good contact between the gas and irrigation solution. Organic material, clay, mineral media, or media containing carbon or impregnated with nutrients or metals shall NOT be allowed.
 2. Media material and configuration shall be suitable for both high airflow and low airflow conditions. Air channeling at low airflow condition shall not be acceptable.
- E. Liquid Distributor:
1. A liquid distribution header shall be provided to uniformly distribute the scrubbing liquid onto the packing material. Internal spray piping shall have flanged connection for easy removal. Without exception the liquid spray distributor system shall be consist of full cone, non-clog spray nozzle attached to the header array. The spray nozzle shall have a minimum free passage diameter of 0.25 inch and shall be specifically designed to be clog resistant. Pressure loss across the nozzle at design capacity shall be no more than 10 psi. The spray nozzles shall be Teflon, polypropylene, PVC or 316 stainless steel. The irrigation piping and nozzle within the vessel shall be readily accessible from the outside of the vessel without any entry into the vessel.
- F. Exhaust Stack:
1. Each tower scrubber shall be furnished with a flanged connection vertical stack fabricated from fiberglass reinforced plastic with flanged connection to the scrubber outlet. Each stack shall be provided with one inch diameter fitting for outlet air sampling.
- G. Lateral Pipe Support:
1. Manufacturer to provide support tabs on side of BTF vessel to attach vertical segment of pipe to vessel for lateral bracing.
 2. Support tabs shall be corrosion resistant.
 3. Vertical support for self weight and/ or uplift of vertical pipe segment shall be the responsibility of pipe supplier.
- H. Identification Tag:
1. Vessel shall be provided with a permanently attached, 16-gauge stainless steel equipment identification plate or label laminated into the final fiberglass coat. The label shall state the following in 1/4-inch die-stamped lettering for the plate or 1-inch lettering for the laminated label.

2. Equipment identification (tag) number shown on Drawings and vessel name "BIOTRICKLING FILTER".
3. Resin type, inner surface reinforcement, and resin Manufacturer's name
4. Date of manufacture
5. Manufacturer's name and address
6. Manufacturer serial number
7. Purchase order number
8. Allowable temperature range
9. Design pressure (vacuum)
10. Vessel dimensions and capacity in cubic feet
11. Operating Weight

I. Neoprene Pad:

1. A 1/4" thick, 60 durometer neoprene rubber sheet shall be placed underneath the scrubber vessel.

J. Ladder and Platform: Size and configuration as indicated on the Drawings and as follows:

1. Ladder: Fabricated from aluminum.
2. Elevated Platform and Structural Members: Fabricated from aluminum for access to the tank top. See Drawings for configuration. Scrubber Manufacturer shall design and supply platform support system. Platform shall be supported from scrubber tower.
3. Ladder Design Live Loads, Deflection, Extension, and Fall Protection System shall all comply with the requirements for Metal Ladders as indicated in Section 05 50 00 - Metal Fabrications and OSHA.
4. Platforms shall be designed to meet OSHA requirements for Walking-Working services. Live load used for design of each platform component shall be a minimum of the greater load effect resulting from a 40 psf distributed load or a 300 pound concentrated load (unfactored).
5. Provide aluminum handrail around platform.
6. Design and fabricate Type 316 stainless steel or FRP support members for anchoring platform to vessel wall.
7. Fasteners:
 - a. Type 316 stainless steel.
8. Secure ladder to the vessel using Type 316 stainless steel or Hastalloy C bolts with polyethylene encapsulated heads.
9. Anchor Bolts:
 - a. Type 316 stainless steel.
10. Ladder shall be equipped with safety rail and fall protection.

2.5 EXHAUST FAN

A. Exhaust Fan:

1. Fan shall have fiberglass reinforced plastic centrifugal backward inclined impeller. The wheel shall be dynamically balanced. Resin shall be suitable for exposure to the specific service conditions. The shaft shall be carbon steel and shall have a stainless steel sleeve. The shaft seal shall be Teflon or Viton.
2. All fans shall be provided with lugs, brackets, or supplied devices to allow the fan to be firmly bolted to concrete equipment pad.
3. Fan shall be rated for Class 1 Div 2 conditions.

B. Bearings shall be heavy duty, self aligning grease lubricated ball type with minimum of 100,000-hour B-10 life. OSHA approved belt guard and shaft guard shall be provided. Motor shall be high-efficiency, TEFC, 1800 RPM with a 1.15 service factor and suitable for 3/60/230-460V. Fan shall be belt driven. Fan shall have a constant V-belt drive. Provide access for greasing bearings, tachometer readings of fan and motor speed without removing the cover. Covers shall be properly ventilated to prevent motor overheating.

1. When bearings are not accessible, extended supply and relief fittings shall be supplied. Both supply and relief fittings shall terminate in the same location.
- C. Fan Housing shall be constructed of fiberglass and reinforced with rigid bracing to increase structural integrity. Fan housing shall be ultraviolet and corrosion resistant. Bearing support brackets shall be positioned to directly oppose belt tension forces. Fan housing shall be a curved scroll design with a 1-inch drain connection at the lowest portion of the fan scroll. The fan inlet shall be slip type and the fan outlet shall have a flanged nozzle.
- D. The fan shall be designed for the following specifications:

Fans	10F1, 10F2, 10F3	
Design Air Flow Rate, cfm	6,300	3,150
S.P. up to BTF Filter Inlet, in. WC (REVISED BY ADDENDUM NO. 1)	~~4.7~~ 18.5	~~48.5~~ 4.7
Approximate Total Pressure Drop, in. WC¹ (REVISED BY ADDENDUM NO. 2)	~~17.0~~ 30.0	~~30.0~~ 17.0
Motor HP	30	30
Notes: 1. Total pressure drop through odor control system to vary by manufacturer. It is the responsibility of the odor control system manufacturer to coordinate final pressure drop with fan manufacturer.		

- E. All fastening and hardware exposed to a corrosive environment shall be Type 316 stainless steel.
- F. Fan base shall be Type 316 stainless steel.
- G. Fan shall be furnished with stainless steel nameplates including information of manufacturer, model number, rated capacity, static pressure, RPM, and any other pertinent data.
- H. Flanged Connections:
 1. Connects to expansion joints, dampers, fan, bio-trickling filter, carbon adsorber, or other equipment shall be flanged fiberglass reinforced plastic, unless otherwise noted in the drawings or specifications. Gaskets shall be EPDM.
 2. Furnish all bolts, nuts, washers, and other fasteners required. Metallic fasteners shall be Type 316 stainless steel. All flange bolts shall be torqued to values as recommended by manufacturer.
- I. Flexible Connector:
 1. Provide flanged expansion joint for inlet and outlet of fan to FRP vessel transition piece. The flange drilling shall be coordinated with fan and transition.
 2. Type: W-design configuration with fully molded integral flanges suitable for service with FRP duct.
 3. The properties of the flexible connectors shall be as follows: Material shall be EPDM. Material shall be resistant to ultraviolet light degradation and shall be suitable for contact with odorous air as specified herein. The backing rings shall be 1/4-inch thick, 2" wide, type 304 stainless steel. The length from flange-to-flange shall be 6" unless shown otherwise. The extension shall be 1 inch, compression shall be 2 inches, lateral offset shall be 2.5 inches, and the thickness shall be 1/4-inch minimum.
 4. Manufacturer shall be:
 - a. Senior Flexonics Pathway
 - b. Or Approved Equal.

- J. Transition Pieces:
1. Provide duct transition pieces between the exhaust fan outlet connection and the bio-trickling filter inlet connection. Transition piece shall be constructed of FRP of the same resin as, and equal or superior in strength to, the adjacent equipment. Dimensions of end connections shall be adjusted to match equipment connection sizes.
 2. Manufacturer shall design transition pieces so that they shall be free from buckling, pulsing, warpage, and sagging at design pressures listed above. Thickness of transition pieces shall be designed using a safety factor of 10:1 for pressure and 5:1 for vacuum service.
- K. The fan shall:
1. Be shipped loose from the scrubber system and be anchored to a concrete pad without vibration isolators.
 2. Have an AMCA seal.
 3. Manufactured by:
 - a. New York Blower
 - b. Hartzell
 - c. Or Approved Equal.
- L. Motor shall be 480 volt, 3 phase, 60 hz suitable for full voltage starting and continuous operation at 40 degrees C ambient temperature at the specified loads. The motor shall be suitable for Class 1 Div 2 conditions and suitable for use with a VFD.
- M. Motor shall be furnished with stainless steel nameplates including information of manufacturer, serial number, model number, horsepower, speed, voltage, amperes, and any other pertinent data.
- N. The motor shall be manufactured by:
1. WEG
 2. Siemens
 3. ABB
 4. Or Approved Equal.
- O. Fan shall be located upstream of Bio-Trickling Filter tower and Carbon Adsorber.

2.6 DAMPERS

- A. Provide manually operated isolation dampers as indicated on the Drawings. Provide motorized dampers as indicated on the Drawings. See Section 23 33 00 - Air Duct Accessories for more information.

2.7 PROCESS CONTROL EQUIPMENT

- A. See Section 40 61 96 Process Control Descriptions - General and 40 61 96.1 Process Control Descriptions - Odor Control for more information.
- B. Without exception all process control equipment shall be provided as a completely integrated system with all components pre-piped and pre-wired by the Manufacturer and shall include:
- C. Fans:
1. Three fans shall be provided in the odor control package. At low flows of 15 ACH, the fans shall be one duty, two standby. At high flows of 30 ACH, the fans shall be two duty, one standby. System shall be designed such that Operator has the ability to choose low flow or high flow and which fan(s) shall be online.

- D. Flow Control Dampers:
1. Six motorized flow control dampers shall be provided in the odor control package. Dampers shall be integrated such that the dampers directly upstream and downstream of a fan shall open when the fan is energized and close when the fan is de-energized.
- E. Insertion Mass Flow Meter
1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. FCI
 - b. Kurz
 - c. Or approved equal.
 2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
 3. Type:
 - a. Insertion heat elements.
 - b. 316 stainless steel body.
 - c. Provide units with an integral transmitter.
 - d. Flow meters shall be of sufficient length to accommodate shut-off valve as shown in the drawings.
 4. Function/Performance:
 - a. Function: To provide a contact output when air flow is sensed in a pipeline.
 - b. Operating Principle: Two 316 Stainless Steel RTDs, one is heated and the other senses the process temperature. The temperature difference between the two RTDs is proportional to the process flow.
 5. Functional:
 - a. Output: Looped power 4-20mA.
 6. Physical:
 - a. Two 316 stainless steel measuring probes.
 - b. Body: 316 stainless steel with a flanged connection.
 - c. 1-inch minimum NPT mounting or otherwise match the process line connection.
 - d. Instrumentation not mounted in instrument racks or stands shall be provided with sunshields when mounted outdoors.
 7. Manufacturer Start-up and Training Services
 - a. Provide manufacturer's start-up and training services as specified in the start-up and training services paragraph.
 8. **Provide flow conditioner if required for proper operation. (ADDED BY ADDENDUM NO. 1)**
- F. Recirculation Pump:
1. ~~As required for system operation, the~~ The recirculation pump shall be supplied pre-piped and pre-wired into the process control skid. The recirculation pump shall be seal-less, magnetic, centrifugal type. The pump shall be totally enclosed, manufactured of polypropylene, and shall include Kynar rear housing. The pump motor shall be TEFC, 3500 rpm, 230/460 VAC/3-Ph/60 Hz and shall include a 1.15 service factor. **(REVISED BY ADDENDUM NO. 1)**
 2. Provide one shelf spare recirculation pump.
- G. Nutrient Feed System:
1. The nutrient pump shall be housed within an insulated and heated Water Control Cabinet for each tower which is mounted at a location convenient to the operation of the system. The nutrient system stores and delivers biological nutrients to the spray nozzle where the solution is circulated through the packing media. The nutrient reservoir shall provide a minimum of 50 gallons of nutrient for 10BTF1. The nutrient feed system shall include a nutrient pump, reservoir, and all piping and equipment necessary to deliver nutrients from the reservoir to the irrigation water.

H. Nutrient Storage Tank:

1. A nutrient reservoir shall be constructed of FRP or UV-resistant HDPE and furnished for the containment of biological nutrients with a minimum capacity of 50 gallons for 10BTF1.
2. Without exception the tank shall be made of vinyl ester fiberglass reinforced plastic or high density polyethylene and be suitable for storage in direct sunlight.
3. The nutrient storage tank shall be sized to provide a minimum of one month nutrient supply.
4. The reservoir shall be provided with bulkhead pipe connections for tank drain, outlet, inlet, pressurized water connection, low level indicator, and vent. Flanged connections shall be of the same materials as the tank wall. Threaded connections shall be of standard NPT. The tank details showing the locations of all openings, nozzles, and appurtenances shall be included in shop drawings and submitted for approval before fabrication of the chemical storage tank.
5. The reservoir shall have an electronic low level indicator and a connection to a pressurized water source that is controlled by a ball valve, as required by manufacturer.
6. Each storage tank shall be insulated and heated to preclude freezing.

I. Irrigation Piping:

1. The piping on the Process support and Control Skid shall be Sch. 80 PVC and shall include all piping from the Water Control Cabinet to the pump(s), an overflow and water level control device with a clear site tube that allows inspection of the blowdown rate and the level of the vessel sump.

J. pH probe:

1. Provide each water control cabinet with a prewired pH probe in the BTF sump.
2. The transmitter shall be remotely mounted on the main control panel.
3. The probe shall send signals and receive power from the main control panel as shown on the drawings.
4. pH measurement shall use the potentiometric measurement method utilizing a glass electrode. The pH sensitive glass membrane surface shall react to the acid content of the solution with a specific voltage, which is measured relative to a reference electrode.
5. Manufacturer: One of the following or equal.
 - a. Sensor: GF 2724 signet pH electrode.
 - b. Transmitter: Signet 8750 with suitable pre-amplifier if required.
 - c. Transmitter performance requirement:
 - 1) Accuracy: within 0.01 pH
 - 2) Repeatability: within 0.01 pH
 - d. Sensor material: glass pH sensor housed in a molded reinforced polypropylene body threaded for insertion, with an in built temperature sensor.
 - e. Transmitter:
 - 1) Should be suitable for panel or field mounting options.
 - 2) Power Supply: 24 VDC with pre-amplifier if required.
 - 3) Output: Isolated 4 to 20 mA DC proportional to pH, Alarm contacts (SPDT) for low pH indication in the main control panel.
 - 4) Display: backlist LCD digital display.
 - 5) Enclosure: NEMA Type 4X.
 - 6) Mounting: panel mounting option.

K. Instrumentation and Controls:

1. The odor control system consists of three fans, one bio-trickling filter (BTF), one carbon adsorber. The ancillary system to the BTF includes a water panel, recirculation pump, nutrient feed tank, nutrient pump, and one water source for the water panel. Foul air from the headworks flows through the fan(s) to the BTF and then continues through the carbon adsorber before discharging into the atmosphere. The water panel combines flows from the recirculation pump, nutrient pump, and water source to feed the combination to the top of the BTF.

- a. At low flows with one fan in operation, the motorized dampers on the suction and discharge of that fan will be open. The motorized dampers on the suction and discharge of the other two fans will remain closed.
 - b. At high flows with two fans in operation, the motorized dampers on the suction and discharge of the fans will be open. The motorized dampers on the suction and discharge of the other fan will remain closed.
 - c. The motorized damper after the discharge of the carbon adsorber will only be used to isolate the carbon adsorber in events when the carbon adsorber needs to be taken offline.
 - d. Under normal operating conditions, the system will be controlled based on operator mode selection in SCADA.
 - e. All motorized dampers provided by odor control system will be controlled by vendor-supplied PLC.
2. Automatic Mode:
- a. There will be two modes that the Owner will select from the SCADA HMI. The first automatic mode is one fan operation. The second automatic mode is two fan operation.
 - b. One Fan Operation Mode:
 - 1) In the One Fan Operation automatic mode, one fan will operate at the flow specified in specification 41 11 29. The odor control system will operate at this setting until another operation mode is selected. The mass flowmeter will operate as the process variable for PID control of the VFD. The VFD will control the fan to a set speed as determined by TAB contractor.
 - 2) Motorized dampers 10CDX and 10CDX on the suction and discharge of the fan will open before the fan ramps up to set speed.
 - 3) Motorized dampers 20FCDX-20FCDX will open to operation set point 1 as determined by TAB contractor.
 - 4) Each motorized damper may have a different control setpoint.
 - c. Two Fan Operation Mode:
 - 1) In the Two Fan Operation automatic mode, two fans will operate at the flow specified in specification 41 11 29. The mass flowmeter will operate the process variable for PID control of the VFDs. The odor control system will operate at this setting until another operation mode is selected.
 - 2) Motorized dampers 10CDX and 10CDX on the suction and discharge of both fans will open.
 - 3) Motorized dampers 20FCDX-20FCDX will open to operation set point 2 as determined by TAB contractor.
 - 4) Each motorized damper may have a different control setpoint
3. Electrical panels shall comply with the requirements of Section 40 67 23 - Control Panels. PLCs shall comply with the requirements of Section 40 63 43 - Programmable Logic Controllers. The electrical control panel shall provide electrical control for the exhaust fan, pumps, and water and nutrient addition systems. The panels that are housed outdoors, shall be provided with sunshields and required air conditioning units.
4. A 480 VAC, 3-phase feed shall be supplied to the panel for use to power the system. The control panel shall include motor starters for fans and pumps. Variable Frequency drives shall comply with the requirements of Section 26 20 23 - Variable Frequency Motor Controllers. Provide fuse protection for all motor circuits. Provide two spare fuses of each size and type.
5. The control panel enclosure shall be of fiberglass construction and rated NEMA 4X 316 SS. The panel shall be mounted at a location outside of hazardous boundaries to system operation and shall be factory tested to full operation with all other components prior to shipment.
- a. Controls:
 - 1) The Vendor Control Panel (VCP) shall have a Programmable Logic Controller. PLC shall be Allen Bradley ControlLogix or CompactLogix.

- a) Plant PLC shall receive at a minimum I/O, via fiber connection from the VCP, as shown on the SCADA Architecture, 90-T101.
 - b) Each PLC shall support IEC Standard 61131-3 for all the following programming languages:
 - i. Ladder (LD)
 - ii. Function Block Diagram (FBD)
 - iii. Structured Text (ST)
 - 2) Provide a panel mount 10" Allen-Bradley PanelView Plus 7 Standard OIT for VCP in accordance with Operator Interface Terminal (OIT). Mount to panel face.
 - 3) Provide network components in accordance with Section 40 66 13 - Networking Equipment and Section 40 66 33 - Fiber Optic Communication Systems.
- 6. The panel shall have the following components or capabilities:
 - a. Fan switch (H-O-A)
 - b. Recirculation pump (H-O-A)
 - c. Nutrient pump switch (H-O-A)
 - d. External Interfaces
 - 1) Dry Contact Outputs
 - a) Run Status (SCADA)
 - b) Run Status (Fan Control)
 - c) Run Status (Recirculation Pump Control)
 - d) Run Status (Nutrient Pump Control)
 - e) Common Alarm
- 7. Each water control cabinet shall be constructed from a NEMA 4X 316 SS cabinet with all internal piping SCH 80 PVC. The panel shall be mounted at a location convenient to system operation. A separate water control cabinet shall be provided for the tower. The cabinet shall contain the following components:
 - a. Recirculation system pressure gauge.
 - b. Make-up water pressure gauge (one per location)
 - c. Heating cable
 - d. pH probe
- 8. Water rotameter shall be provided for control of water application rates.
- 9. Both the electrical control panel and water control cabinet shall be installed outside of the classified hazardous area.

L. Recycle Piping:

- 1. All recycle piping, irrigation water and drain piping, and blowdown piping shall be SCH 80 PVC. All external piping shall be insulated and heat traced by the Contractor as required in specification sections 40 41 13 Heat Tracing and 40 42 00 Process Mechanical Insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The complete biological odor control system shall be installed in strict accordance with the Manufacturer's recommendations. The system shall be compatible with the basic provisions shown.

3.2 FIELD ENGINEERING/STARTUP

- A. The biological odor control system Manufacturer shall provide field engineering startup assistance to startup, test, and arrive at proper operating conditions. Minimum service time required shall be as listed in Subsection 1.6 4-5, MANUFACTURER'S SERVICES. If additional time is required for reasons attributable to the odor control equipment supplier, the costs shall

be borne by the supplier. Should the extra time be required because of reasons attributable to the Contractor, these charges will be borne by the Contractor at prevailing rates. **(REVISED BY ADDENDUM NO. 1)**

3.3 PERFORMANCE TESTING

A. General:

1. The Contractor shall be responsible for all costs associated with odor control system testing.

B. Functional Testing:

1. Using non-odorous ambient air, the entire odor control system shall be operated for NOT less than 24 continuous hours in order to demonstrate the mechanical and electrical integrity of the system. Any mechanical or electrical breakdowns, unusual vibrations, or control sequencing problems shall be considered sufficient cause to reject the test. Inability to successfully complete the functional testing in five tries shall be considered cause for the construction manager to reject the odor control system. Contractor shall balance all air flows prior to system performance testing.

C. Performance Testing:

1. **Two performance tests are required: (ADDED BY ADDENDUM NO. 1)**
 - a. **One test after sufficient acclimation time.**
 - b. **One test to be performed one month prior to the end of the warranty period.**
2. Performance tests shall be conducted after the Testing and Balancing Report for the entire ductwork system is submitted and approved by Engineer per Section 44 31 83 Adjusting and Balancing Odor Control Systems.
3. The performance tests shall be conducted after sufficient acclimation time and at such time as all anticipated odorous air streams are present in the scrubber inlet. The time of the tests and detailed test procedure shall be submitted for approval prior to the testing period.
4. During testing, scrubber overflow, recirculation and scrubber air flow rates shall be held constant. Changes in scrubber system operating conditions shall NOT be permitted. All fine-tuning of operating conditions shall be performed prior to testing.
5. Design operating conditions shall be maintained for a minimum of 4 hours. During this time, all pertinent operating parameters shall be monitored and recorded, sufficient sampling and analysis shall be conducted to demonstrate that flow rates are at design conditions.
6. Hydrogen sulfide concentration shall be measured in each scrubber inlet and outlet. Inlet and outlet levels shall be measured once every 30 minutes using a portable H₂S analyzer such as Interscan, Jerome or equal.
7. Results:
 - a. A description of the performance tests shall be submitted. The hydrogen sulfide compound removal efficiency shall be as specified in the design and performance requirements. Should scrubber system performance NOT meet any of the above requirements, that system shall have failed the performance tests. The Contractor shall make any additions or modifications to that scrubber system as may be necessary, at no additional cost to the Owner, and the performance tests for that system shall be repeated in its entirety.

3.4 OPERATION AND MAINTENANCE TRAINING

- A. The Contractor shall provide the services of a factory-trained Manufacturer's representative to provide training of the Owner's personnel in the proper operation and maintenance of the equipment. Prior to final acceptance, the Contractor shall furnish the Construction Manager with two copies of the Manufacturer's certifications. Training shall be performed in accordance with Section 01 75 00 - Startup Testing and Training.

- B. A trained Manufacturer's representative to visit site, verify operations of biological odor control system, and retrain Owner personnel in proper operation and maintenance of equipment. Site visits shall be conducted every 6 months throughout the warranty period. (ADDED BY ADDENDUM NO. 1)**

3.5 MANUFACTURER'S REPRESENTATIVE

- A. The Contractor shall include in his bid all costs associated with providing the services of the Manufacturer's field representative for checking, aligning, testing, placing in operation, and Owner training.

END OF SECTION