CHAPTER 110
SUPPLEMENTAL TREATMENT PROCESSES

111. PHOSPHORUS REMOVAL BY CHEMICAL TREATMENT

111.1 System Flexibility

___ Systems shall be designed with sufficient flexibility to allow for several operational adjustments in chemical feed location, chemical feed rates, and for feeding alternate chemical compounds.

111.2 Process Requirements

111.2.1 Dosage

___ The required chemical dosage shall include the amount needed to react with the phosphorus in the wastewater, the amount required to drive the chemical reaction to the desired state or completion, and the amount required due to inefficiencies in mixing or dispersion. Excessive chemical dosage should be avoided.

111.2.2 Chemical Feed Points

___ Considerable flexibility in feed location should be provided, and multiple feed points are recommended.

111.2.3 Flash Mixing

___ Each chemical must be mixed rapidly and uniformly with the flow stream. Where separate mixing basins are provided, they should be equipped with mechanical mixing devices. The detention period should be at least 30 seconds.

111.2.4 Flocculation

___ The flocculation equipment should be adjustable in order to obtain optimum floc growth, control deposition of solids, and prevent floc destruction.

111.2.5 Liquid - Solids Separation

___ The velocity through pipes or conduits from flocculation basins to settlings basins should not exceed 1.5 fps (0.46 m/s) in order to minimize floc destruction. Entrance works to settling basins should also be designed to minimize floc shear.

___ Settling basin design shall be in accordance with criteria outlined in Chapter 60. For design of the sludge handling system, special consideration should be given to the type and volume of sludge generated in the phosphorus removal process.

111.2.6 Filtration

___ Effluent filtration shall be considered where effluent phosphorus concentrations of less than 1 mg/1 must be achieved.

111.3 Feed Systems

111.3.1 Location

___ All liquid chemical mixing and feed installations should be installed on corrosion resistant pedestals and elevated above the highest water level anticipated (including emergencies).

___ Lime feed equipment should be located so as to minimize the length of slurry conduits. All slurry conduits shall be accessible for cleaning.

111.3.2 Liquid Chemical Feed System

___ Liquid chemical feed pumps should be of the positive displacement type with variable feed rate. Pumps shall be selected to feed the full range of chemical quantities required for the phosphorus mass loading conditions anticipated with the largest unit out of service.

___ Screens and valves shall be provided on the chemical feed pump suction lines.

___ An air break or anti-siphon device shall be provided where the chemical solution stream discharges to the transport water stream to prevent an induction effect and overfeed.

111.3.3 Dry Chemical Feed System

___ Each dry chemical feeder shall be equipped with a dissolver that is capable of providing a minimum 5-minute retention at the maximum feed rate.

___ Polyelectrolyte feed installations should be equipped with two solution vessels and transfer piping for solution make-up and daily operation.

___ Make-up tanks shall be provided with an eductor funnel or other appropriate arrangement for wetting the polymer during the preparation of the stock feed solution. Adequate mixing should be provided by a larger-diameter low-speed mixer.

111.4 Storage Facilities

111.4.1 Size

___ Storage for a minimum of 10 days' supply should be provided.

111.4.2 Location

___ The liquid chemical storage tanks and tank fill connections shall be located within a containment structure having a capacity exceeding the total volume of all storage vessels. Discharge line valves shall be located adjacent to the storage tank and within the containment structure.

___ Auxiliary facilities, including pumps and controls, within the containment area shall be located above the highest anticipated liquid level. Containment areas shall be sloped to a sump area and shall not contain floor drains.

___ Bag storage should be located near the solution make-up point.

111.4.3 Accessories

___ Platforms, ladders, and railings should be provided as necessary to afford convenient and safe access to all filling connections, storage tank entries, and measuring devices.

___ Storage tanks shall have reasonable access provided to facilitate cleaning.

111.5 Other Requirements

111.5.1 Materials

___ All chemical feed equipment and storage facilities shall be constructed of materials resistant to chemical attack by all chemicals normally used for phosphorus treatment.

111.5.2 Temperature, Humidity and Dust Control

___ Precautions shall be taken to prevent chemical storage tanks and feed lines from reaching temperatures likely to result in freezing or chemical crystallization at the concentrations employed. A heated enclosure or insulation may be required. Consideration should be given to temperature, humidity, and dust control in all chemical feed room areas.

111.5.3 Cleaning

___ Consideration shall be given to the accessibility of piping. Piping should be installed with plugged wyes, tees, or crosses at changes in direction to facilitate cleaning.

111.5.4 Drains and Drawoff

___ Above-bottom drawoff from chemical storage and feed tanks shall be provided to avoid withdrawal of settled solids into the feed system. A bottom drain shall also be installed for periodic removal of accumulated settled solids.

111.6 Hazardous Chemical Handling

___ The requirements of Section 47.1 shall be met.

112. HIGH RATE EFFLUENT FILTRATION

112.1 General

112.1.1 Applicability

___ Granular media filters may be used as a tertiary treatment device for the removal of residual suspended solids from secondary effluents. Where effluent suspended solids requirements are very low, where secondary effluent quality can be expected to fluctuate significantly, or where filters follow a treatment process where significant amounts of algae will be present, a pre-treatment process such as chemical coagulation and sedimentation or other acceptable process should precede the filter units.

112.1.2 Design Considerations

___ Consideration should be given in the plant design to providing flow-equalization facilities to moderate filter influent quality and quantity.

112.2 Filter Types

___ Filters may be of the gravity type or pressure type. Pressure filters shall be provided with ready and convenient access to the media for treatment or cleaning. Where greases or similar solids that result in filter plugging are expected, filters should be gravity type.

112.3 Filtration Rates

112.3.1 Allowable Rates

___ Filtration rates shall not exceed 5 gpm/ft^2 (3.4 1/m^2*s) based on the maximum hydraulic flow rate applied to the filter units.

112.3.2 Number of Units

___ Total filter area shall be provided in two or more units, and the filtration rate shall be calculated on the total available filter area with the largest unit out of service.

112.4 Backwash

112.4.1 Backwash Rate

The backwash rate shall be adequate to fluidize and expand each media layer a minimum of 20% based on the media selected. The backwash system shall be capable of providing a variable backwash rate having a maximum of at least 20 gpm/ft^2 (13.6 1/m^2*s) and a minimum backwash period of 10 minutes.

112.4.2 Backwash Pumps

___ Pumps for backwashing filter units shall be sized and interconnected to provide the required rate to any filter with the largest pump out of service. Filtered water shall be used as the source of backwash water. Waste filter backwash shall be recycled for treatment.

112.4.3 Backwash Surge Control

___ The rate of return of waste filter backwash water to treatment units shall be controlled such that the rate does not exceed 15% of the design average daily flow rate to the treatment units. The hydraulic and organic load from waste backwash water shall be considered in the overall design of the treatment plant. Surge tanks shall have a minimum capacity of two backwash volumes, although additional capacity should be considered to allow for operational flexibility. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest unit out of service.

112.4.4 Backwash Water Storage

___ Total backwash water storage capacity provided in an effluent clearwell or other unit shall equal or exceed the volume required for two complete backwash cycles.

112.5 Filter Media

112.5.1 Media Specifications

___ The following table provides minimum media depths and the normally acceptable range of media sizes. The uniformity coefficient shall be 1.7 or less. The designer has the responsibility for selection of media to meet specific conditions and treatment requirements relative to the project under consideration.

Minimum Depth and Effective Size of Filter Media

Medium	Criterion	Single Media Filter	Dual Media Filter	Triple Media Filter
Anthracite	Depth	--	20 inches	20 inches
	Eff. Size	--	1.0 – 2.0 mm	1.0 – 2.0 mm
Sand	Depth	48 inches	12 inches	10 inches
	Eff. Size	1.0 – 4.0 mm	0.5 – 1.0 mm	0.6 – 0.8 mm
Garnet or Similar Material	Depth	--	--	2 inches
	Eff. Size	--	--	0.3 – 0.6 mm

112.6 Filter Appurtenances

___ The filters shall be equipped with washwater troughs, surface wash or air scouring equipment, means of measurement and positive control of the backwash rate, equipment for measuring filter head loss, positive means of shutting off flow to filter being backwashed, and filter influent and effluent sampling points. If automatic controls are provided, there shall be a manual override for operating equipment, including each individual valve essential to the filter operation. The underdrain system shall be designed for uniform distribution of backwash water (and air, if provided) without danger of clogging from solids in the backwash water. Provision should be made to allow periodic chlorination of the filter influent or backwash water to control slime growths.

112.7 Reliability

___ Each filter unit shall be designed and installed so that there is ready and convenient access to all components and the media surface for inspection and maintenance without taking other units out of service. The need for housing of filter units shall depend on expected extreme climatic conditions at the treatment plant site. As minimum, all controls shall be enclosed. The structure housing filter controls and equipment shall be provided with adequate heating and ventilation equipment to minimize problems with excess humidity.

112.8 Proprietary Equipment

___ Where proprietary filtration equipment not conforming to the preceding requirements is proposed, data which supports the capability of the equipment to meet effluent requirements under design conditions shall be provided. Such equipment will be reviewed on a case-by-case basis at the discretion of MDEQ in accordance with Section 43.2.

113. INTERMITTENT SAND FILTRATION

113.1 Introduction

The following standards are for single-stage intermittent sand filters that are used to polish lagoon, activated sludge, or trickling filter effluent. Other uses are also allowable. Consideration shall be given to pretreating lagoon effluent for algae reduction. All earthen basin filters shall comply with Section 44.4.

113.2 Filter Size and Number

___ There shall be at least two filters.

___ The filters should be of the same size and shape to provide ease of operation.

113.3 Hydraulic Loading Rate

___ The hydraulic loading rate with the largest filter out of operation should be in the range of 0.4 to 0.6 MGD/ac.

113.4 Media

113.4.1 Sand

___ Sand is the most commonly used filtration media. Other materials such as crushed shells may be approvable on a case-by-case basis.

___ The effective size should be 0.3 to 1.0 mm. The uniformity coefficient should be no greater than 3.5.

___ The filter media depth should be 24 to 36 inches.

113.4.2 Gravel Base

___ Clean graded gravel, preferably placed in at least three layers, should be placed around the underdrains and to a depth of at least six inches over the top of the underdrains. Suggested gradation for the three layers are bottom: 12 to 3/4 inches, middle: 3/4 to 1/4 inch, and top: 1/4 to 1/8 inch.

Other support media may be allowable on a case-by-case basis.

113.5 Underdrain System

___ The filter shall be provided with perforated pipe or similar underdrains. Proprietary systems may be used in lieu of conventional underdrain-gravel bed construction.

___ Underdrains shall be sloped to the outlet and shall be placed on 10 foot maximum centers.

___ The underdrain shall drain sufficiently between dosings to provide an open air channel.

___ Vertical riser vents shall be provided at both ends of each underdrain pipe and shall be located so as not to be overtopped at maximum dosing depth.

113.6 Influent System

___ The system should be able to apply the entire daily hydraulic load in less than six hours.

___ Splash pads or other methods shall be provided to prevent erosion of the filter medium.

113.7 Sand Cleaning

___ If spent filter medium is stored on-site, it shall be stored in a steel, plastic, concrete, or similar container or in an earthen impoundment which meets the requirements of Section 104.2 and all subsections.

___ There shall be no discharge from the spent filter media holding area or cleaning unit. All discharge fluids shall be sent to the WWTP upstream of the major biological treatment process.

113.8 Surface Runoff

___ The filter and spent medium storage area shall be designed so as to preclude the entry of surface runoff.

114. MICROSCREENING

114.1 General

114.1.1 Applicability

___ Microscreening units may be used following a biological treatment process for the removal of residual suspended solids. Selection of this unit process should consider final effluent requirements, the preceding biological treatment process, and anticipated consistency of biological process to provide a high quality effluent. Microscreens shall not be used following lagoons or free water surface wetland treatment facilities.

114.1.2 Design Considerations

___ Pilot plant testing on existing secondary effluent is encouraged. Where pilot studies so indicate, where microscreens follow trickling filters, or where effluent suspended solids requirements are less than 10 mg/1, a pretreatment process such as chemical coagulation and sedimentation shall be provided. Care should be taken in the selection of pumping equipment ahead of microscreens to minimize shearing of floc particles. The process design shall include influent flow equalization facilities.

114.2 Screen Material

___ The microfabric shall be a material demonstrated to be durable through long-term performance data. The aperture size must be selected considering required removal efficiencies, normally ranging from 20 to 35 microns. The use of pilot plant testing for aperture size selection is recommended.

114.3 Screening Rate

The screening rate shall be selected to be compatible with available pilot plant test results and selected screen aperture size, but shall not exceed 5 gpm/ft^2 (3.40 l/m^2*s) of effective screen area based on the maximum hydraulic flow rate applied to the units. The effective screen area shall be considered as the submerged screen surface area less the area of screen blocked by structural supports and fasteners. The screening rate shall be that applied to the units with the largest unit out of service.

114.4 Backwash

___ All waste backwash water generated by the microscreening operation shall be recycled for treatment. The backwash volume and pressure shall be adequate to assure maintenance of fabric cleanliness and flow capacity. Equipment for backwash of at least 8 gpm/linear foot (1.66 1/m*s) of screen length, 60 psi (4.22 kgf/cm^2) capacity, respectively, shall be provided. Backwash water shall be supplied continuously by multiple pumps, including one standby, and should be obtained from microscreened effluent. The rate of return of waste backwash water to treatment units shall be controlled such that the rate does not exceed 15% of the design average daily flow rate to the treatment plant. If the hydraulic and organic load from waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest pump out of service. Provisions should be made for measuring backwash flow.

114.5 Appurtenances

___ Each microscreen unit shall be provided with automatic drum speed controls with provisions for manual override, a bypass weir with an alarm for use when the screen becomes blinded to prevent excessive head development, and means for dewatering the unit for inspection and maintenance. Bypassed flows must be segregated from water used for backwashing. Equipment for control of biological slime growths shall be provided. The use of chlorine should be restricted to those installations where the screen material is not subject to damage by the chlorine.

114.6 Reliability

___ A minimum of two microscreen units shall be provided, each unit being capable of independent operation at the design average flow. A supply of critical spare parts shall be provided and maintained. All units and control shall be enclosed in a heated and ventilated structure with adequate working space to provide for ease of maintenance.

115. POST AERATION

115.1 Initial Dissolved Oxygen Concentration

___ An initial dissolved oxygen (DO) concentration of zero should be assumed. An initial DO concentration higher than 2.0 mg/1 shall not be assumed.

115.2 Maximum Effluent Temperature

___ The post aerator shall be designed to provide the required DO at the maximum effluent temperature.

___ The actual one-in-ten-year high effluent temperature may be used. Otherwise, a maximum temperature of at least 25EC (77EF) shall be used.

115.3 Cascade Aeration

115.3.1 Type

___ Cascade aeration shall be of the “step” type, with each step at least six (6) inches (15 cm) high and twelve (12) inches (30 cm) deep (front to rear).

115.3.2 Height

___ The total height shall not be less than eight (8) feet (2.4 m), and shall be calculated with the Barrett formula.