

**SUBCHAPTER H: NATURAL TREATMENT UNITS**

**§§217.201 - 217.213**  
**Effective December 4, 2015**

**§217.201. Applicability.**

This subchapter establishes the minimum requirements for Imhoff tanks, constructed wetlands, and all lagoons used to store treated, untreated, or partially treated domestic wastewater, including facultative lagoons, aerated and partially aerated lagoons, stabilization lagoons, raw influent storage lagoons, treated effluent storage lagoons, evaporative lagoon systems, and overland flow processes, except that lagoons used for reclaimed water under Chapter 210 of this title (relating to Use of Reclaimed Water) must comply with the requirements of that chapter.

Adopted November 4, 2015

Effective December 4, 2015

**§217.202. Primary and Secondary Treatment Units.**

(a) A primary treatment unit may be an aerated lagoon, a partially aerated lagoon, a facultative lagoon, an evaporative lagoon, or an Imhoff tank.

(b) A secondary treatment unit may be a stabilization lagoon, a constructed wetland, an evaporative lagoon, or an overland flow process. A secondary treatment unit may be used for polishing and tertiary treatment.

(c) A treated effluent storage lagoon downstream of the sampling location in the wastewater treatment facility permit is not considered a treatment unit for the purposes of this chapter.

(d) A secondary treatment unit must be preceded by a primary treatment unit.

Adopted November 4, 2015

Effective December 4, 2015

**§217.203. Design Criteria for Natural Treatment Units.**

(a) This section applies to all earthen lagoons and earthen treatment units in a wastewater treatment facility, including constructed wetlands, facultative lagoons, aerated lagoons, partially aerated lagoons, stabilization lagoons, evaporative lagoons, and storage lagoons. Storage lagoons are considered treatment units for the purposes of this chapter if they hold wastewater that is not final treated effluent, such as raw influent or wastewater that has received intermediate treatment.

(b) **Flow Distribution.** The shape and size of a treatment unit must ensure uniform distribution of the wastewater flow.

(c) **Windbreaks and Screening.**

(1) A windbreak or vegetative screening must be used if operation of the treatment system could cause spray to drift off of the property.

(2) The use, type, and extent of windbreaks or vegetative screening must be approved in writing by the executive director.

(d) **Maximum Liner Permeability.**

(1) Except as provided in paragraph (3) of this subsection, constructed wetlands, facultative lagoons, aerated lagoons, partially aerated lagoons, stabilization lagoons, evaporative lagoons, and storage lagoons must be constructed with a liner material that has a coefficient of permeability less than  $1 \times 10^{-7}$  centimeters per second for a thickness of:

(A) 2.0 feet for water depths less than or equal to 8.0 feet; and

(B) 3.0 feet for water depths greater than 8.0 feet.

(2) A liner must extend from the lowest elevation in a lagoon or constructed wetland, up to an elevation of 2.0 feet above normal water elevation in the lagoon or constructed wetland.

(3) If a lagoon is constructed to store treated wastewater authorized as reclaimed water under Chapter 210 of this title (relating to Use of Reclaimed Water), the lagoon liner must comply with §210.23 of this title (relating to Storage Requirements for Reclaimed Water).

(e) **Compliance with the Liner Permeability Requirements.** A lagoon must be lined and tested according to the requirements of this subsection. The engineering report must include the results of all tests required by this subsection.

(1) **Sampling Requirements for Soil Liners.**

(A) **Sample Analysis.** Soil liner material must be sampled and analyzed before construction. All samples of the liner material must meet the following requirements:

centimeters per second;

(i) the coefficient of permeability must be less than  $1 \times 10^{-7}$

200 mesh sieve;

(ii) at least 30% of the liner material must pass through a

30%; and

(iii) the liner material must have a liquid limit greater than

greater.

(iv) the liner material must have a plasticity index of 15 or

(B) Preconstruction Sampling for Unamended In-Situ Liners. Permeability testing for an unamended in-situ soil liner requires undisturbed core samples of the liner material. At least one undisturbed core sample must be analyzed for every 0.25 acre of liner surface area on the bottom of each lagoon or constructed wetland. At least one additional undisturbed core sample must be analyzed for every 0.25 acre of liner surface area from each side of each lagoon or constructed wetland. All undisturbed core samples must have a coefficient of permeability less than  $1 \times 10^{-7}$  centimeters per second. The engineering report must demonstrate that the in-situ soil liner meets the minimum thickness requirements in subsection (d)(1) of this section.

(C) Preconstruction Sampling for Imported Soil Liners and Amended In-Situ Soil Liners. Four samples must be tested for every 0.25 acres of liner surface area in each lift according to subparagraph (A)(ii) - (iv) of this paragraph. . At least one out of every four samples must be tested for permeability according to subparagraph (A)(ii) of this paragraph. If samples are collected before compaction, molded samples of the liner material mixture may be tested instead of undisturbed core samples for imported soil liners and amended in-situ soil liners.

(D) Post-construction Sampling. A minimum of one undisturbed core sample must be analyzed after the liner is complete for each 0.25 acre of liner surface area on the bottom of each lagoon or constructed wetland. At least one additional undisturbed core sample must be analyzed for every 0.25 acre of liner surface area from each side of each lagoon or constructed wetland. The coefficient of permeability must be less than  $1 \times 10^{-7}$  for each sample. An unamended in-situ liner does not require post-construction sampling if it meets the pre-construction requirements in subparagraphs (A) and (B) of this paragraph and the construction requirements in paragraph (2)(B) of this subsection.

(2) Soil Liner Construction.

(A) Amended In-situ or Imported Soil Liner Construction. All amended in-situ or imported soil liners must comply with the following requirements:

(i) liner material must be placed in loose lifts that are each no more than 8.0 inches in thickness;

(ii) each lift must be compacted to at least 95% standard proctor density at -1% to +3% optimum moisture according to American Standards for Testing and Materials (ASTM) D 698;

(iii) each lift must be no more than 6.0 inches thick after compaction and the completed liner must meet the minimum thickness requirements in subsection (d)(1) of this section; and

(iv) the in-situ subgrade must be scarified before placement of the lowest lift.

(B) Unamended In-situ Soil Liner Construction. All unamended in-situ soil liners must comply with the following requirements.

(i) The liner must include at least one 8.0 inch loose lift of excavated in-situ material that is compacted to no more than 6.0 inches at 95% standard proctor density at -1% to +3% optimum moisture according to ASTM D 698.

(ii) The in-situ subgrade must be scarified before placement of the lowest lift.

(3) Synthetic Membrane Liner Construction. All synthetic membrane liners must comply with the following requirements.

(A) A synthetic membrane liner must have a minimum thickness of 40 mils.

(B) A synthetic membrane liner must include an underdrain with a leachate detection and collection system.

(C) Synthetic membrane liner material must be able to withstand constant sunlight without degrading.

(D) Soil compaction beneath a synthetic liner must meet the liner manufacturer's requirements.

(f) Embankment Design and Construction.

- (1) The top of an embankment must be at least 10.0 feet wide.
  - (2) The engineering report must justify all inner and outer embankment slopes steeper than 1.0 foot vertical to 4.0 feet horizontal from the top of the embankment.
  - (3) Inner and outer embankment slopes steeper than 1.0 foot vertical to 3.0 feet horizontal are prohibited.
  - (4) All embankments must be protected against erosion by establishing grass, paving, riprapping, or any other method approved in writing by the executive director.
  - (5) All vegetated embankments must have a minimum cover of 6.0 inches of topsoil.
- (g) Disinfection. Unless otherwise specified in the wastewater treatment facility's wastewater permit, chemical or ultraviolet disinfection is not required if a detention time of at least 21 days is provided in the plant-free water surface with full sun exposure in accordance with §309.3(g) of this title (relating to Application of Effluent Sets).
- (h) Sampling Point Significance. The size or design of a treatment unit upstream of the permitted sampling point must not be based on the design of any storage lagoon or other structure downstream of the permitted sampling point.
- (i) Stormwater Drainage. A natural treatment system must be designed and constructed to prevent stormwater from draining into the system.
- (j) Piping. A natural system must have piping that allows water in each lagoon or wetland cell to be re-routed to a different lagoon or wetland cell for maintenance.
- (k) Freeboard.
- (1) A lagoon must have a minimum of 2.0 feet of freeboard above the normal operating level if the lagoon's normal water surface area is less than 20 acres.
  - (2) A lagoon must have a minimum of 3.0 feet of freeboard above the normal operating level if the lagoon's normal water surface area is 20 acres or more.
  - (3) A constructed wetland cell must have at least 2.0 feet of freeboard above the normal operating level, or the freeboard required to manage the selected wetland plant population, whichever is greater.

(l) Prohibition of Synthetic Liners for Constructed Wetlands. The use of a synthetic membrane liner for a free water surface constructed wetland is prohibited.

Adopted November 4, 2015

Effective December 4, 2015

**§217.204. Imhoff Tanks.**

(a) Settling Compartment.

(1) The minimum length-to-width ratio of a settling compartment is 2.0 to 1.0.

(2) A tank inlet must provide uniform flow distribution across the width of a settling compartment.

(3) The septum walls must slope to the center of a compartment at an angle of at least 50 degrees but not more than 60 degrees from horizontal. The septum walls must create an overlap with a continuous slot that is at least 8.0 inches wide between the walls to allow solids to be dispersed into the digestion compartment. To prevent gases from escaping through the slot, one of the septum walls must continue past the slot to create a slot overhang of at least 8.0 inches.

(4) The depth between the water level at design flow and the plane of a slot must not be more than 9.0 feet.

(5) At least 18 inches of freeboard must be provided above the normal water level.

(b) Surface Loading.

(1) The settling compartment surface loading rate must not exceed 800 gallons per day per square foot of settling compartment area under design flow conditions.

(2) The longitudinal velocity of wastewater through a settling compartment must not exceed 1.0 foot per second under peak flow conditions.

(c) Scum Baffles. An inlet and an outlet of an Imhoff tank must include scum baffles with a height that meets the water levels at all flows from minimum flow to peak flow.

(d) Gas Vents.

(1) An Imhoff tank must include gas vents with a total area not less than 20% of the total Imhoff tank surface area. The total Imhoff tank surface area must be included in the engineering report.

(2) At least one vent opening must be large enough to allow equipment into the digestion compartment for maintenance.

(e) Digestion Compartment Loading. The digestion compartment minimum volume must be 3.5 cubic feet per capita or 20.5 cubic feet per pound of influent five-day biochemical oxygen demand (BOD<sub>5</sub>) per day, whichever is greater.

(f) Imhoff Tank Dimensions. The total depth of an Imhoff tank must not be less than 16.5 feet from the water surface to the bottom of a digestion compartment at design flow.

(g) Sludge Removal.

(1) The digestion compartment of an Imhoff tank must have a sludge withdrawal pipe.

(2) A sludge withdrawal pipe must have a minimum diameter of 8.0 inches and include a provision for regular cleaning.

(3) A digestion compartment design must allow a portable pump to remove accumulated sludge.

(h) Odor Management.

(1) The design of an Imhoff tank must minimize the effect of odor from the gas vents.

(2) The executive director may require a bio-filter, a carbon filter, or other odor control device to minimize odor.

(i) Treatment Efficiency.

(1) An Imhoff tank must be followed by at least one subsequent treatment unit.

(2) A design may assume that an Imhoff tank removes 35% of the influent BOD<sub>5</sub>.

(j) Material and Construction.

(1) An Imhoff tank must be constructed of reinforced and sealed concrete.

(2) Each component of an Imhoff tank must be resistant to the corrosive effects of a wastewater environment.

Adopted November 4, 2015

Effective December 4, 2015

**§217.205. Facultative Lagoons.**

(a) Configuration, Inlets, and Outlets.

(1) The length-to-width ratio of a facultative lagoon must be 3.0 to 1.0.

(2) The flow in a facultative lagoon must be from an inlet along one end of the lagoon to an outlet at the opposite end of the lagoon.

(3) The length of a facultative lagoon must be oriented in the direction of the prevailing winds with the inlet side located such that debris will be blown toward the inlet.

(4) A facultative lagoon must have inlet baffles to collect floatable material when no pre-screening is provided.

(5) An outlet must be adjustable to allow the water level of a facultative lagoon to vary under normal operating conditions.

(b) Depth.

(1) The deeper portion of a facultative lagoon near the inlets must have a minimum depth of 12 feet to provide sludge storage and anaerobic treatment.

(2) The deeper portion of a facultative lagoon must cover at least 25% of the area of the lagoon bottom.

(3) The remainder of a facultative lagoon must have a minimum depth of 8.0 feet.

(c) Organic loading. The organic loading must not exceed 150 pounds of five-day biochemical oxygen demand (BOD<sub>5</sub>) per acre per day based on the surface area of the facultative lagoon.

(d) Odor Control.

(1) A facultative lagoon inlet must be at least 24 inches below the water surface to minimize odor.

(2) An outlet must be at least 12 inches below the water surface, but not further below the water surface than a distance equal to one-half the depth of the lagoon at the outlet.

(3) The design of a facultative lagoon must allow for recirculation of at least 50%, but not more than 100% of the design flow.

(4) The design of a facultative lagoon must prevent siphoning of lagoon contents through a submerged inlet.

(e) Removal efficiency. The design of a facultative lagoon must not be based on more than 50% removal of the influent BOD<sub>5</sub>.

Adopted November 4, 2015

Effective December 4, 2015

**§217.206. Aerated Lagoons.**

(a) The requirements of this section apply to both completely mixed aerated lagoons and partially mixed aerated lagoons, unless otherwise specified.

(b) A minimum of 1.6 pounds of oxygen per pound of influent five-day biochemical oxygen demand (BOD<sub>5</sub>) must be maintained in an aerated lagoon system, even with the largest single aeration unit in a lagoon system out of service.

(c) The aeration equipment must have an audio-visual alarm system. If a wastewater treatment facility is not staffed 24 hours per day, the alarm system must be connected to a telemetry system, such as an auto dialer or Supervisory Control and Data Acquisition system, with battery backup.

(d) The BOD<sub>5</sub> removal in each aerated lagoon must be calculated using the following equation:

Figure: 30 TAC §217.206(d)

**Equation H.1.**

$$E = 1 - \frac{1}{1 + K \left( \frac{V}{Q} \right)}$$

Where:

E = fraction of five-day biochemical oxygen demand removed in aerated lagoon

K = first order removal rate constant, day<sup>-1</sup>

V = aeration basin volume, million gallons

Q = design influent wastewater flow rate, million gallons per day.

(1) The value of K for domestic wastewater in a completely mixed lagoon is 0.50 day<sup>-1</sup> at 20 degrees Celsius. The value of K for domestic wastewater in a partially mixed lagoon is 0.28 day<sup>-1</sup> at 20 degrees Celsius.

(2) The value of K must be adjusted for the minimum monthly water temperature using the following equation:

Figure: 30 TAC §217.206(d)(2)

**Equation H.2.**

$$K_T = K_{20} \times 1.06^{T-20^{\circ}\text{C}}$$

Where:

K<sub>T</sub> = the lowest average water temperature during any 30-day period.

K<sub>20</sub> = K value at 20° C

T = lowest average water temperature (°C) expected during any 30-day period

(3) The value of K must be determined for high-strength or industrial wastewater by either a laboratory study or an evaluation of an existing wastewater treatment facility treating wastewater with similar organic strength and industrial contributions.

(e) Aeration Equipment.

(1) The size of the aeration equipment in an aerated lagoon must be able to supply the oxygen demand determined in subsection (b) of this section.

(2) For the purpose of sizing aeration equipment, an aerated lagoon must comply with the mechanical and diffused air requirements in §217.155(c) of this title (relating to Aeration Equipment Sizing).

(3) If multiple partially mixed aerated lagoons are used in series, the power input may be reduced as the influent BOD<sub>5</sub> to each lagoon decreases.

(f) Aerated Lagoon Design Requirements. An aerated lagoon system must be designed according to the requirements for a wastewater treatment lagoon in §217.203(f) of this title (relating to Design Criteria for Natural Treatment Facilities) and §217.207(d) of this title (relating to Stabilization Lagoons).

(g) Scour Prevention. An earthen-lined aerated lagoon system must include a concrete scour pad in each area of the earthen liner that is subject to a velocity equal to or greater than 1.0 foot per second.

Adopted November 4, 2015

Effective December 4, 2015

**§217.207. Stabilization Lagoons.**

(a) Primary treatment must remove the settleable and floatable solids in the influent prior to the wastewater entering a stabilization lagoon.

(b) Odor Management.

(1) A stabilization lagoon must be located so that odors from the stabilization lagoon will not cause a nuisance.

(2) If uncontaminated water is available, a stabilization lagoon must be pre-filled with uncontaminated water to the 2.0 foot level at start-up.

(3) A stabilization lagoon system must include a piping arrangement that allows the recirculation of effluent from a final lagoon to the influent side of an initial stabilization lagoon.

(4) A stabilization lagoon may return recirculation water by surface spray to assist in maintaining aerobic conditions at the lagoon surface and to reduce potential odor.

(c) Minimum Number of Wastewater Stabilization Lagoons. At least two stabilization lagoons are required to comply with secondary treatment limits. The stabilization lagoons must be operated in series, following the primary treatment unit.

(d) Stabilization Lagoon Design.

(1) The minimum length-to-width ratio of a stabilization lagoon is 3.0 to 1.0.

(2) Inlet and outlet structures must be adjustable to assist in controlling vegetative growth. Inlet and outlet structures must allow the water level to be raised and lowered by at least 6.0 inches.

(e) Pipe and Hydraulic Equipment.

(1) All structures and pipes in a stabilization lagoon must be sized to transport at least 250% of the wastewater treatment facility's design flow.

(2) The inlet and outlet structures must be sized to convey the volume contained within the top 6.0 inches of a lagoon within a 24-hour period, based on the normal water level at design flow and the corresponding pressure head.

(3) The pipe and recirculation system must allow a stabilization lagoon system to comply with the wastewater treatment facility's permitted effluent limitations, even with any one lagoon out of service.

(f) Maximum Surface Organic Loading Rate for Stabilization Lagoons.

(1) The maximum surface organic loading rate on a stabilization lagoon series is 35 pounds (lbs) of five-day biochemical oxygen demand (BOD<sub>5</sub>) per acre per day.

(2) The maximum surface organic loading rate on the first lagoon in a stabilization lagoon series is 75 lbs of BOD<sub>5</sub> per acre per day.

(3) The surface organic loading rate applied to a stabilization lagoon series is equal to the total influent organic loading minus any reduction in organic load provided by the primary treatment units.

(g) Inlet and Outlet Structures.

(1) A stabilization lagoon outlet must include removable baffles to prevent floating material from being discharged, and must be constructed to operate correctly as the level of the lagoon surface varies under normal operating conditions.

(2) An outlet must be at least 18 inches but not more than 24 inches below the water surface in a stabilization lagoon to control the discharge of duckweed and floating algae.

(3) A multipurpose control structure may be used to facilitate normal operational functions such as drawdown, flow distribution, adjusting water depth, flow

measurement, sampling, access for pump for recirculation, chemical addition, and exclusion of floating materials. A multipurpose control structure may also be used to minimize the number of special purpose structures in a stabilization lagoon.

(4) A pipe embankment penetration must have a seep water-stop collar.

(5) A stabilization lagoon must have a drainpipe that allows the stabilization lagoon to be emptied for maintenance and may use a pump as part of a drainage system. If a permanent drain pipe will not be installed, a temporary pipe suction station must be provided.

Adopted November 4, 2015

Effective December 4, 2015

**§217.208. Evaporative Lagoons.**

(a) Design.

(1) If evaporative lagoons are used, the wastewater treatment facility must have at least two evaporative lagoons.

(2) The primary evaporative lagoon must provide at least 60% of the total surface area of the total evaporative lagoon system.

(3) The number and size of evaporative lagoons must provide adequate evaporation for the design flow during periods of low evaporation. For the purposes of this chapter, the low evaporation rate used in design must be the lowest annual evaporation rate in the past 25 years from the Texas Water Development Board's precipitation and lake evaporation dataset for the quadrangle where the evaporation lagoon is located.

(b) Odor Management. An evaporative lagoon must be located so that odors from the evaporative lagoon will not cause a nuisance.

(c) Configuration, Depth, and Loading.

(1) An evaporative lagoon may be constructed in a round, square, or rectangular shape. The corners of a square or rectangular shaped evaporative lagoon must be rounded in order to minimize accumulation of floating materials.

(2) The depth of an evaporative lagoon is dependent on its location within the lagoon system, as set forth in subparagraphs (A) and (B) of this paragraph.

(A) The maximum operating depth for a primary evaporative lagoon is 5.0 feet, but the area around an inlet must be designed with additional depth for solids deposition according to the criteria in §217.205 of this title (relating to Facultative Lagoons).

(B) The maximum operating depth for a secondary evaporative lagoon is 8.0 feet.

(3) Evaporation and Organic Loading.

(A) The size of an evaporative lagoon system must be based on the evaporation rate for the site and a maximum allowable organic loading rate.

(B) The evaporation loss must be calculated by using the Penman-Monteith method or a comparable, established method.

(C) An evaporative lagoon system must be sized to account for the influent flows and precipitation from a 25-year frequency, one-year rainfall event in accordance with §309.20(b)(3)(B) of this title (relating to Land Disposal of Sewage Effluent), unless the engineering report includes an alternate method of disposing of the wastewater, along with supporting documentation.

(D) The five-day biochemical oxygen demand (BOD<sub>5</sub>) loading on a primary evaporative lagoon must not exceed 150 pounds of BOD<sub>5</sub> per acre of surface area per day.

(d) Embankment. The embankments for an evaporative lagoon must be constructed in accordance with §217.203(f) of this title (relating to Design Criteria for Natural Treatment Facilities).

(e) Inlet and Outlet Structures.

(1) An influent line for an evaporative lagoon must terminate into a manhole located along the embankment edge.

(2) An inlet manhole invert must be a minimum of 6.0 inches above the maximum high water level of a primary evaporative lagoon or provide other means to prevent backflow into an upstream treatment unit.

(3) A submerged discharge pipe must extend from a manhole along and anchored to the bottom of an evaporative lagoon.

(4) An inlet discharge pipe must discharge onto a concrete apron in a depression near the center of the primary evaporative lagoon to prevent scour. A concrete apron must be at least 2.0 square feet in surface area, be at least 8.0 inches thick, and be resistant to the corrosive effects of a wastewater environment.

(5) Inlet and outlet structures for an evaporative lagoon must be designed and constructed in a manner that allows the water surface elevation to be varied during normal operating conditions.

Adopted November 4, 2015

Effective December 4, 2015

### **§217.209. Constructed Wetlands.**

(a) Types of Constructed Wetlands. A constructed wetland may be either a free water surface system or subsurface flow system.

(b) Natural Wetlands. The use of natural wetlands for wastewater treatment is prohibited. For the purposes of this chapter, a natural wetland is an area which was not constructed for wastewater treatment that meets the definition of wetlands in 40 Code of Federal Regulations, Part 230.

#### (c) Constructed Wetland Design.

(1) A constructed wetland must be preceded by primary treatment or secondary treatment.

(2) A primary treatment system that precedes a constructed wetland must be designed to control odor and algae.

(3) A primary treatment system must produce an effluent quality with no more than 150 milligrams per liter of five-day biochemical oxygen demand to discourage anaerobic conditions and stress on vegetative communities in any subsequent wetland treatment unit.

(4) A wastewater treatment facility that uses a constructed wetland as the means of complying with a permit effluent limit must be sized and designed to ensure that the permit limitations will be met even when any one wetland cell is out of service. The engineering report must include water balance calculations and the potential effect of evaporation on the predicted effluent concentrations.

(d) Vegetation. A constructed wetland must have a diverse vegetative community of emergent and floating plants to minimize any adverse impact from potential disease, insect pests, or species-specific toxicity. A constructed wetland must include a diversity

of plants selected from the following categories of emergent plants, floating plants, or both.

(1) Emergent plants for use in constructed wetlands include:

- (A) *Schoenoplectus spp.* (bulrush);
- (B) *Sagittaria spp.* (arrowhead);
- (C) *Phragmites spp.* (reeds);
- (D) *Juncus spp.* (rushes);
- (E) *Eleocharis spp.* (spikerush);
- (F) *Carex spp.* (sedges);
- (G) *Caladium spp.* (elephant ear);
- (H) various aquatic grass species (e.g., wild rice); and

(I) other appropriate emergent plant species approved in writing by the executive director.

(2) Floating plants for use in constructed wetlands include:

- (A) *Lemna spp.* (duckweed);
- (B) *Hydrocotyle umbellata* (water pennywort);
- (C) *Limnobium spongia* (frogbit);
- (D) *Nymphaea spp.* (water lily);
- (E) *Wolffia spp.* (water meal); or

(F) other appropriate floating plant species approved in writing by the executive director.

(3) The vegetation used in a constructed wetland must be suitable for the local growing conditions. The use of indigenous plants is recommended if the species have been demonstrated effective in a constructed wetland wastewater environment.

The engineering report must identify the plants that will be used in each constructed wetland.

(4) Plans for harvesting aquatic plants from water in the state must be reviewed with the United States Army Corps of Engineers to determine if regulatory coordination is required.

(5) Gathering seed plants from natural wetlands must minimize any impact on the harvested plant community and the natural wetlands.

(6) The use of any harmful or potentially harmful wetland plant or organism is subject to review by the Texas Parks and Wildlife Department, as required by 31 TAC §§57.111 - 57.118 and §§57.251 - 57.258 (relating to Definitions; General Rules; Exceptions; Health Certification of Harmful or Potentially Harmful Exotic Shellfish; Transportation of Harmful or Potentially Harmful Exotic Species; Exotic Species Transport Invoice; Exotic Species Permit: Application Requirements; Exotic Species Permit Issuance; Definitions; General Provisions; Permit Application; Denial; Renewal; Amendment; Reporting and Recordkeeping; and Prohibited Acts, respectively).

(e) Maintenance of a constructed wetland must not result in a deterioration of effluent quality.

(1) The use of herbicides, insecticides, and fertilizers in a constructed wetland is prohibited.

(2) Floating Material Removal.

(A) A constructed wetland must be designed to allow the removal of an algal mat or other floating material prior to the effluent entering each cell of the constructed wetland.

(B) A removal mechanism must be a screen, a submerged adjustable inlet, a baffle, or another method approved in writing by the executive director. The removal mechanism must be justified in the engineering report.

(C) The removed floating material must be stored and disposed of in a manner that minimizes odor and complies with the requirements of Chapter 330 of this title (relating to Municipal Solid Waste).

(3) The operation and maintenance manual for a wastewater treatment facility that has a constructed wetland must include a detailed description and schedule for maintaining the constructed wetlands. The maintenance plan must include a

schedule and procedure for removing overabundant live plant material and dead plant material.

(f) A constructed wetland system must have an established plant community and must be functioning properly before wastewater effluent is processed. The engineering report must include a management and oversight program that specifies construction scheduling, plant species selection, planting practices, and start-up procedures.

(g) Liners.

(1) The liner for a constructed wetland system must comply with the requirements of §217.203(d) and (e) of this title (relating to Design Criteria for Natural Treatment Facilities).

(2) A layer of productive topsoil at least 6.0 inches thick must be placed above a liner to encourage root propagation.

(h) Berms. A berm of a constructed wetland must comply with the requirements of §217.203(f) of this title.

(i) Flood Hazard Analysis. A constructed wetland must be protected from flooding according to the requirements of §217.35 of this title (relating to One Hundred-Year Flood Plain Requirements).

(j) Nitrification. A constructed wetland that provides nitrification is an innovative and non-conforming technology and is subject to the requirements of §217.7(b)(2) of this title (relating to Types of Plans and Specification Approvals).

(k) Allowed Uses. A constructed wetland may be used as a secondary treatment unit, as an advanced secondary treatment unit, or for polishing wastewater effluent. A constructed wetland may not be used for primary treatment.

Adopted November 4, 2015

Effective December 4, 2015

**§217.210. Constructed Wetlands--Free Water Surface Design.**

(a) Areas of emergent vegetation in a free water surface (FWS) wetland must have a maximum water depth less than or equal to 24 inches at design flow.

(b) Plants.

(1) Emergent plant spacing must be no more than 66 inches on center.

(2) If floating plants are used in a FWS wetland, the wetland must also contain emergent plants.

(c) Multiple Cells. An FWS wetland must include multiple cells that can be operated independently, allowing an individual cell to be removed from service while maintaining system operations.

(d) System Size. An FWS wetland system must be sized to meet permit effluent limits, even when any single cell is removed from service.

(e) Bottom slope.

(1) An FWS wetland cell must have adequate bottom slope, or other means such as strategically placed deep-water zones, to facilitate drainage for maintenance.

(2) Plants selected for an FWS wetland cell shall be compatible with the water depths under all anticipated operational flow conditions.

(f) Parallel trains. An FWS wetland must have parallel treatment trains to increase operational flexibility.

(g) Wind protection. An FWS wetland cell must either be oriented to avoid prevailing winds perpendicular to the process flow direction, or must use elevated berms or vegetative windbreaks.

(h) Inlets and Outlets.

(1) The inlets and outlets of an FWS wetland cell must ensure uniform distribution of influent flow and uniform collection of effluent flow across the entire cell cross section.

(2) An FWS wetland must have multiple inlet and outlet devices designed to minimize scouring of wetland substrate caused by locally high velocity effluent flow.

(3) Each inlet and outlet device in an FWS wetland must be adjustable to allow variations in the operational water level.

(4) Submergence. An FWS wetland inlet must be submerged under normal operational conditions.

(5) Inspection and Cleaning. An FWS wetland must be designed to allow for the inspection and cleaning of inlet and outlet devices.

(i) Organic Loading and Treatment Efficiency.

(1) The design of an FWS wetland must be based on the design organic loading of the influent to the FWS wetland.

(2) Organic removal efficiency for FWS wetlands must be calculated from the area-based loading rate equation found in Figure: 30 TAC §217.210(i)(2), unless the engineering report justifies an alternate method to determine the organic removal efficiency by identifying a method, the sources of the method, and all supporting calculations.

Figure: 30 TAC §217.210(i)(2)

**Equation H.3.**

$$C_o = C^* + (C_i - C^*) \exp^{-\frac{Ka}{0.0365Q}}$$

Where:

$C_i$  = influent five-day biochemical oxygen demand (BOD<sub>5</sub>) concentration, milligrams per liter (mg/l)

$C_o$  = target effluent BOD<sub>5</sub> concentration, mg/l

$C^*$  = wetland background limit, mg/l

(for total suspended solids (TSS),  $C^* = 5.1 = 0.16C_i$ )

(for BOD<sub>5</sub>,  $C^* = 3.5 + 0.053 C_i$ )

$K$  = first-order areal rate constant:

(34 meters/year (m/yr) @ 20° C for BOD<sub>5</sub>)

(1,000 m/yr @ 20° C for TSS)

$a$  = is required wetland area, hectare (active treatment area, not including dike, buffers, etc.)

$Q$  = design flow in cubic meters per day

(j) Vector Control.

(1) The design of an FWS wetland must include mosquito control by:

(A) using mosquito fish (*Gambusia spp.*) or other natural predators;

(B) maintaining aerobic conditions; or

(C) using other biological controls.

(2) A design must minimize the potential for damage to wetlands caused by mammals such as nutria and muskrats.

Adopted November 4, 2015

Effective December 4, 2015

**§217.211. Constructed Wetlands--Subsurface Flow System General Design.**

(a) A wetted subsurface media must allow adequate root penetration. The type of subsurface media must be identified in the engineering report.

(b) The operational water depth of a subsurface flow system (SFS) wetland must not exceed the lesser of:

(1) 18 inches at design flow; or

(2) the maximum normal root depth of the emergent plant species used in the SFS wetland.

(c) Seasonal draw down of the water level must be performed to encourage deeper root penetration into the wetted media.

(d) Plant spacing must be sufficient to allow maturity of a wetlands flora ecosystem, but must not exceed 36 inches on center.

(e) Configuration. An SFS wetland must include the following minimum configuration standards:

(1) Multiple cells. An SFS wetland must include multiple cells that can be operated independently, allowing individual cells to be removed from service while maintaining system operations.

(2) Cell Size. SFS wetland cells must meet permit effluent limitations, even when any single cell is removed from service.

(3) Hydraulic profile.

(A) An SFS wetland must maintain between 6.0 inches and 9.0 inches of dry media cover at design flow. The wetland must have at least 2.0 inches of upstream media cover during peak flow conditions, and not more than 12.0 inches of upstream media cover during diurnal low flow conditions.

(B) An SFS wetland hydraulic profile must be based on Figure 1: 30 TAC §217.211(e)(3)(B), unless an alternate design method is justified in the engineering

report. The engineering report must include the method, the source of the method, and all supporting calculations and documentation.

Figure 1: 30 TAC §217.211(e)(3)(B)

**Equation H.4. Darcy's Law.**

$$Q = K_s \times A \times S$$

Where:

Q = Design flow (gallons/day)

K<sub>s</sub> = Media hydraulic conductivity (gallons/square foot/day)  
 (see Figure 2: 30 TAC §217.211(e)(3)(B), Table H.1.)

S = Hydraulic gradient (foot/foot)

A = Cross sectional area perpendicular to the flow (square feet)

Figure 2: 30 TAC §217.211(e)(3)(B)

**Table H.1. - Typical Media Characteristics**

<b>Media</b>	<b>Effective Size (inches)</b>	<b>Porosity (%)</b>	<b>Hydraulic Conductivity (gallons/square foot/day)</b>
Fine Gravel	5/8	38	185,000
Medium Gravel	1.25	40	250,000
Coarse Rock	5.0	45	2,500,000

(4) Maximum depth. The maximum wetted media depth of an SFS wetland is the lesser of:

(A) 24 inches at design flow; or

(B) the maximum normal root depth for a planned primary population of emergent plant species.

(5) Minimum slope. An SFS wetland cell must have an adequate bottom slope to facilitate drainage for maintenance and to maintain media water depth over the entire cell length under all operational flow conditions.

(6) Parallel trains. An SFS wetland must have parallel treatment trains to increase operational flexibility.

(f) Flow Distribution. An SFS wetland must be designed with effective flow distribution and collection by meeting the following standards for inlets and outlets, submergence, maintenance, and staged influent feed.

(1) Inlets and Outlets.

(A) The inlet and outlet system of an SFS wetland cell must ensure uniform distribution of influent flow and uniform collection of effluent flow across an entire cell.

(B) The inlet and outlet devices of an SFS wetland cell must not cause locally high velocities that could result in movement of wetland media.

(C) Each inlet and outlet system must be adjustable to allow variation in operational water level and flooding of a cell for weed control.

(2) Submergence. Each inlet and outlet of an SFS wetland must be below the media surface.

(3) Maintenance. Inlet and outlet devices must allow inspection, cleaning, and maintenance.

(4) Staged influent feed. If an average influent five-day biochemical oxygen demand concentration greater than 200 milligrams per liter is anticipated, an SFS wetland must allow for staged influent feed to improve process control.

(g) Organic Loading and Treatment Efficiency.

(1) A constructed wetland process must be based on the design organic loading of the influent to the constructed wetland.

(2) The design of an SFS wetland must be based on the organic removal treatment efficiency for an SFS wetland on Equation H.5. in Figure: 30 TAC §217.211(g)(2), unless an alternate method to determine the organic removal treatment efficiency is justified in the engineering report. The engineering report must include the method, the source of the method, and all supporting calculations.

Figure: 30 TAC §217.211(g)(2)

**Equation H.5.**

$$C_o = C^* + (C_i - C^*) \exp^{-\frac{Ka}{0.0365Q}}$$

Where:

$C_i$  = influent five-day biochemical oxygen demand (BOD<sub>5</sub>) concentration, milligram per liter (mg/l)

$C_o$  = target effluent BOD<sub>5</sub> concentration, mg/l

$C^*$  = wetland background limit, mg/l

(for total suspended solids (TSS)  $C^* = 7.8 + 0.063C_i$ )

(for BOD<sub>5</sub>,  $C^* = 3.5 + 0.053C_i$ )

$K$  = first-order areal rate constant:

(180 meters per year (m/yr) @ 20° C for BOD<sub>5</sub>)

(3,000 m/yr @ 20° C for TSS)

$a$  = is required wetland area, hectare (active treatment area, not including dike, buffers, etc.)

$Q$  = design flow in cubic meters per day

(h) Temperature. An SFS wetland must be able to treat the wastewater treatment facility's wastewater at all water temperatures.

(i) Vector Control. Vegetation maintenance, including removal of excessive plant litter and detritus, is required to limit mosquito production.

(j) Media Design. SFS wetland media must meet the following minimum requirements.

(1) The media must be hard rock, slag, or other clean, comparable media material.

(2) The media must contain less than 0.1% by weight of clay, sand, and other fine materials.

(3) The media materials must have a Mohs hardness of at least 5.0.

(4) The media must be resistant to acidic conditions.

(5) Synthetic media is a non-conforming or innovative technology and is subject to the requirements of §217.7(b)(2) of this title (relating to Types of Plans and Specifications Approvals).

(6) Media gradation and uniformity must be used to determine the SFS wetland's hydraulic conductivity.

(7) The media must be placed in an SFS wetland by light-weight equipment to prevent introduction of clay or other undesirable materials, to avoid compaction, clogging of the media, and damage to the liner.

(8) If an SFS wetland has gravel media larger than 1.5 inches in diameter, it must include a top layer of smaller gravel to encourage healthy plant rooting. The layer of smaller gravel must be above the normally saturated media zone. Also, an SFS wetland must include a transitional (medium grade) layer between small gravel and coarse gravel to minimize small gravel migration into lower void spaces.

Adopted November 4, 2015

Effective December 4, 2015

**§217.212. Overland Flow Process.**

(a) An overland flow process is a non-conforming technology and is subject to the requirements of §217.7(b)(2) of this title (relating to Types of Plans and Specifications Approvals).

(b) The distribution system for an overland flow process must ensure uniform sheet flow of the wastewater onto and across the overland flow terraces.

Adopted November 4, 2015

Effective December 4, 2015

**§217.213. Integrated Facultative Lagoons.**

(a) Non-conforming technology. An integrated facultative lagoon is a non-conforming technology and is subject to the requirements of §217.7(b)(2) of this title (relating to Types of Plans and Specifications Approvals).

(b) Integrated Facultative Lagoon Design.

(1) The length-to-width ratio of an integrated facultative lagoon must be 3.0 to 1.0.

(2) A pit must not be less than 0.25 acre in total surface area.

(3) The outer lagoon area must not be less than 10 times the surface area of the pit.

(4) A pit must have adequate volume to contain:

(A) 0.1 cubic foot per capita per year of sludge storage for a minimum of 20 years; and

(B) two days of design flow above the sludge storage area.

(5) The up-flow velocity in the pit must be less than 2.0 feet per day at design flow.

(6) If an integrated facultative lagoon has more than one pit, influent flow must be split proportional to the pit volumes.

(7) An inlet must be located in the pit portion of a lagoon.

(8) An outlet must be at a depth of 1.0 foot from the lagoon surface.

(9) An integrated facultative lagoon must meet the buffer zone requirements specified in §309.13 of this title (relating to Unsuitable Site Characteristics).

(10) Depth.

(A) A pit must be at least 15 feet deep during normal operating conditions, measured from the water surface to the influent inlet point.

(B) An integrated facultative lagoon must have berms around the pit.

(C) The berm height must be at least 5.0 feet or one-half the depth of the outer lagoon, whichever is greater.

(D) The distance from the water surface elevation during normal operating conditions to the top of the berm around a pit must be at least 5.0 feet.

(11) Organic Loading. The organic loading into a pit must not exceed 300 pounds of five-day biochemical oxygen demand per acre of total lagoon area per day.

(12) Odor Control.

(A) An inlet to a pit must be 3.0 feet above the bottom of the lagoon and the influent flow must be directed downward.

(B) An integrated facultative lagoon must be capable of recirculating at least 50% of the design flow from an outlet of the downstream lagoon.

(C) Oxygenated water from a downstream stabilization lagoon must be recirculated to the surface of the integrated facultative lagoon.

(D) An integrated facultative lagoon must prevent siphoning of lagoon contents through a submerged inlet.

**(13) Removal Efficiency.**

(A) The design of an integrated facultative lagoon must not be based on more than 60% organic removal efficiency in the pit.

(B) The design of an integrated facultative lagoon must not be based on a subsequent organic removal efficiency of more than 50% in the outer portion of the integrated facultative lagoon.

(C) The design organic removal efficiency for the entire integrated facultative lagoon must not exceed 80%.

(14) Detention Time. An integrated facultative lagoon must provide a minimum of 21 days hydraulic retention time at design flow.

Adopted November 4, 2015

Effective December 4, 2015